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NATIONAL OFFICERS OF EXECUTIVE COMMITTEE.

WILLIAM E. SMYTHE, CHAIRMAN.

FRED L. ALLES, SECRETARY.

IRRIGATION COMMISSION FOR UTAH.

Members of Commission.

1893. —◆— 1894.

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Executive Committee,
Chairman.

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L. W. SHURTLIFF, Ogden.

L. HOLBROOK, Provo.

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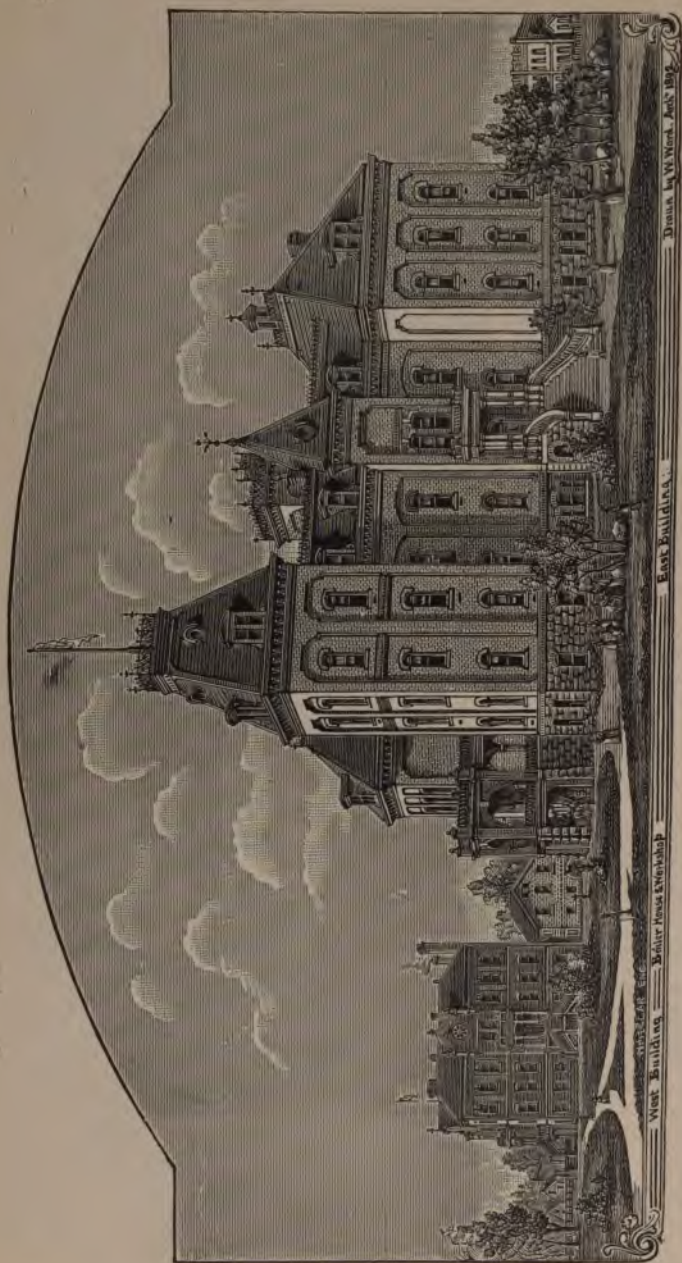
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Secretary.



UNIVERSITY OF UTAH.

West Building

Bellevue House

Knightsbridge

East Building

Main Building

Irrigation in Utah.

A BOOK PUBLISHED BY DIRECTION OF THE
UTAH IRRIGATION COMMISSION.

REPORT OF THE IRRIGATION COMMISSION
TO THE
THIRD NATIONAL IRRIGATION CONGRESS
HELD AT
DENVER, SEPTEMBER, 1894.

ARTICLES CONCERNING IRRIGATION WORK AND CONDITIONS
IN UTAH, AND PROBLEMS OF THE ARID WEST.

SALT LAKE CITY, UTAH,
1895.

IRRIGATION AND OTHER STATISTICS

OF THE

— TERRITORY OF UTAH. —

MAIN PHYSICAL FEATURES.

Utah is situated between the parallels of 37 and 42 degrees north latitude and the meridians of 109 and 114 degrees west of longitude. It lies on the same parallels as Colorado, Kansas, Nebraska, Missouri, Illinois, Kentucky, Virginia, Spain, Italy, France, and Corea. Utah, in fact, belongs to the great Rocky Mountain system, its valleys being elevated from 2,700 to 7,000 feet, while its mountain peaks reach a height of 10,000 to 12,000 feet above the sea. About one-half of the Territory is on the eastern side of the Wasatch Mountains, and within what is known as the great basin. This basin occupies western Utah, northern Nevada, and parts of California, Oregon, and Idaho. It has no outlet, the drainage being toward two great depressions at the southern end. There are salt lakes, one on the western side under the Nevada mountains, and the other under the base of the Wasatch Mountains, called Great Salt Lake. There are many minor lakes that receive the drainage of small areas which do not flow into either of these depressions, but once they all flow into one or the other of them. These lakes have no outlet, and the water that flows into them evaporates by the heat of the sun. The average elevation of the great basin is from 4,200 to 5,000 feet above sea level. Most of the inhabited portion of Utah lies at the western base of the Wasatch Mountains and on the eastern side of the Great Basin. The eastern half of Utah and a small portion of the southern part lies on the western side of the Wasatch Mountains, and belongs to the drainage of the Colorado River and its tributaries. Its valleys range from 2,700 on the south to 7,000 feet on the north. In the former, figs, almonds, cotton, and delicate fruits are raised, while in the latter only small grain and potatoes are grown.

The eastern part of the Territory is drained by the Rio Colorado and its tributaries; the western part, by streams that

head in the Wasatch and the high plateaus of the central part, and find their way into the salinas and the desert sands of the Great Basin. Thus we have the Rio Colorado drainage area, and the Desert drainage area; the former about two-fifths, the latter about three-fifths of the total area.

Utah occupies the central portion in the arid region, and therefore the details of irrigation in this Territory possess more than ordinary interest, from the fact that they represent conditions intermediate between those of the north and south, and east and west. Besides this, the irrigation methods and systems have been developed by men of English-speaking origin, who, unaided by capital or previous experience, have introduced methods of their own, and, taught by repeated failures, finally achieved success.

On the belt of country lying between Great Salt Lake and the Wasatch Mountains, the local rainfall is much greater than the general rainfall of the region. The water evaporated from the lake is carried by the westerly winds to the adjacent mountains on the east and again condensed, and the rainfall thus produced extends somewhat beyond the area occupied by the mountains, so that the foothills and contiguous bench lands receive a modicum of this special supply.

In the early history of irrigation in this country the lands were over-watered, but experience has shown that irrigation is most successful when the least amount of water is used necessary to a vigorous growth of the crops; that is, a greater yield is obtained by avoiding both scanty and excessive watering; but the tendency to over-water the lands is corrected only by extended experience. A great many of the waterways are so rudely constructed that much waste ensues. As irrigating methods are improved, this wastage will be avoided; so in assuming that a cubic foot of water per second will irrigate an average of 100 acres of land, it is at the same time assumed that only the necessary amount of water will be used, and that the waterways will eventually be so constructed that the waste now almost universal will be prevented.

The recent returns to the Utah Irrigation Commission show an average waste of 70 per cent., and it is to the recent report of this Commission (page 12) that we refer for detailed data concerning the irrigated lands of Utah, and for the *duty* of water, to the article "Profits from Irrigation in Utah," page 57.

Whatever conditions future developments may bring about, the present water supply in Utah Territory is surface. It depends entirely upon the fall of snow in the winter, and to a slight degree upon the rainfall during the spring and fall months. As

a consequence the character of the water supply is found in the mountain streams. The fall of snow in the mountains is incomparably greater than in the valleys, and it lasts much longer, for the reason that the cold is much severer.

The snow packs in the ravines until almost as hard and solid as stones. The solidifying is materially assisted by what are termed "January thaws," the result of a marked relaxation in the severity of the weather, which generally occurs during the month of January. The temporary relaxation is invariably followed by a renewal of the rigor of winter, when the snow which has settled and become packed by the thaw, freezes until it is almost a solid mass of ice. The snow is the source of all streams in Utah save the little running water that comes through rains.

The volume of these streams depends entirely upon the season of the year. During the winter months the supply is very small, for the reason that the quantity of melting snow is at its minimum and the cold has a tendency to stay the flow. With the disappearance of winter and the increased warmth of the sun, the snow begins to melt, the volume of water increases and continues to grow, until puny and tiny streams are swollen into rushing torrents, sometimes causing great damage from the overflowing of their banks. The water supply attains its maximum height between the 10th and 20th of the month of June. This statement may be given the force that attaches to a rule almost, if not entirely, without exception. The solidifying and freezing of the snow in winter, as above stated, makes certain the tenure of the water supply that would otherwise be both uncertain and disastrous; it prevents the too rapid melting, that would otherwise result in absolutely uncontrollable torrents for a period, and thus makes the streams available for agricultural purposes.

The experience of Utah farmers as to the best methods for increasing and controlling the water supply would be available only to people surrounded by similar country with like elementary conditions existing. The introduction of genuine artesian wells and utilization of the sub-flow may considerably increase the irrigable acreage. Experiments, sufficiently thorough to demonstrate the success that would attend the digging or boring of such wells in Utah, have not been made. The best opinions, however, are that the geological conditions existing in Utah are peculiarly favorable to their introduction and successful development.

It may be safe to state, however, that if complete and thorough methods of saving were introduced, most of the arable land in the Territory, if it could be reached, could be well and thoroughly irrigated; this, too, without resorting to artesian wells, so vast is

the amount of water that runs to waste during the winter, spring and early summer months.

As now ascertained the average first cost of water right in Utah, \$10.55 per acre, is noticeably great, being largely due to the manner in which the ditches and canals are made. Nearly all are laid out and constructed by farmers of ordinary education, without the use of surveying instruments. As a consequence, few of the more important works laid out in this manner have proved serviceable without great changes, involving in many instances the reconstruction of almost the entire system. The perseverance shown in many of these cases is remarkable.

On the other hand, the annual cost of 91 cents per acre is remarkably low, from the fact that farmers have done all the work of cleaning and making the small annual repairs necessary after the canals and ditches were in successful operation. It should be noted, however, that the maintenance is, as a general thing, comparatively poor, and that the main canals and ditches receive only enough labor to keep the water flowing. It undoubtedly would be far more economical to spend a larger sum annually, and thus save much water which is lost through evaporation and seepage, due to the poor condition of the channel. The changes now being made in the construction of permanent works, scientifically built, while they may not materially reduce the cost, will insure a stability of construction and maintenance which heretofore has been as variable as the rainfall.

As heretofore stated, the increase and decrease in the water supply depends entirely upon the fall of snow in the winter and, in an unimportant degree, upon the fall of rain in the fall, spring and early summer months. A very noteworthy fact, attested on the best authority, is that for a period of years there has been a steady increase in the water supply. It has been thought by many that the claim of increased water has been more imaginary than real. The claim, however, has been verified by measurements made in Great Salt Lake, which is the reservoir for many of the largest mountain streams, including the Jordan, which is the outlet of Utah Lake, the Bear River, the Ogden, Weber, Logan, and Blacksmith Fork, and innumerable smaller streams.

The lake has a shore line of 350 miles, and since 1856 the water has increased 14 feet in depth; though not at present quite that much; and Great Salt Lake, depending as it does entirely upon the inflowing of mountain streams, and that amount of water which is not consumed by agricultural utilization, shows beyond question that there has been a marked increase in the water supply.

This rise in the body of the water of the lake has taken place, it must be remembered, during a period when there was a rapid increase in the demand for water for agricultural purposes.

Where irrigation has been applied for a few years there has been a perceptible decrease in the amount of water necessary to irrigate the land properly. The decrease is placed about 25 per cent.

METHODS OF IRRIGATION.

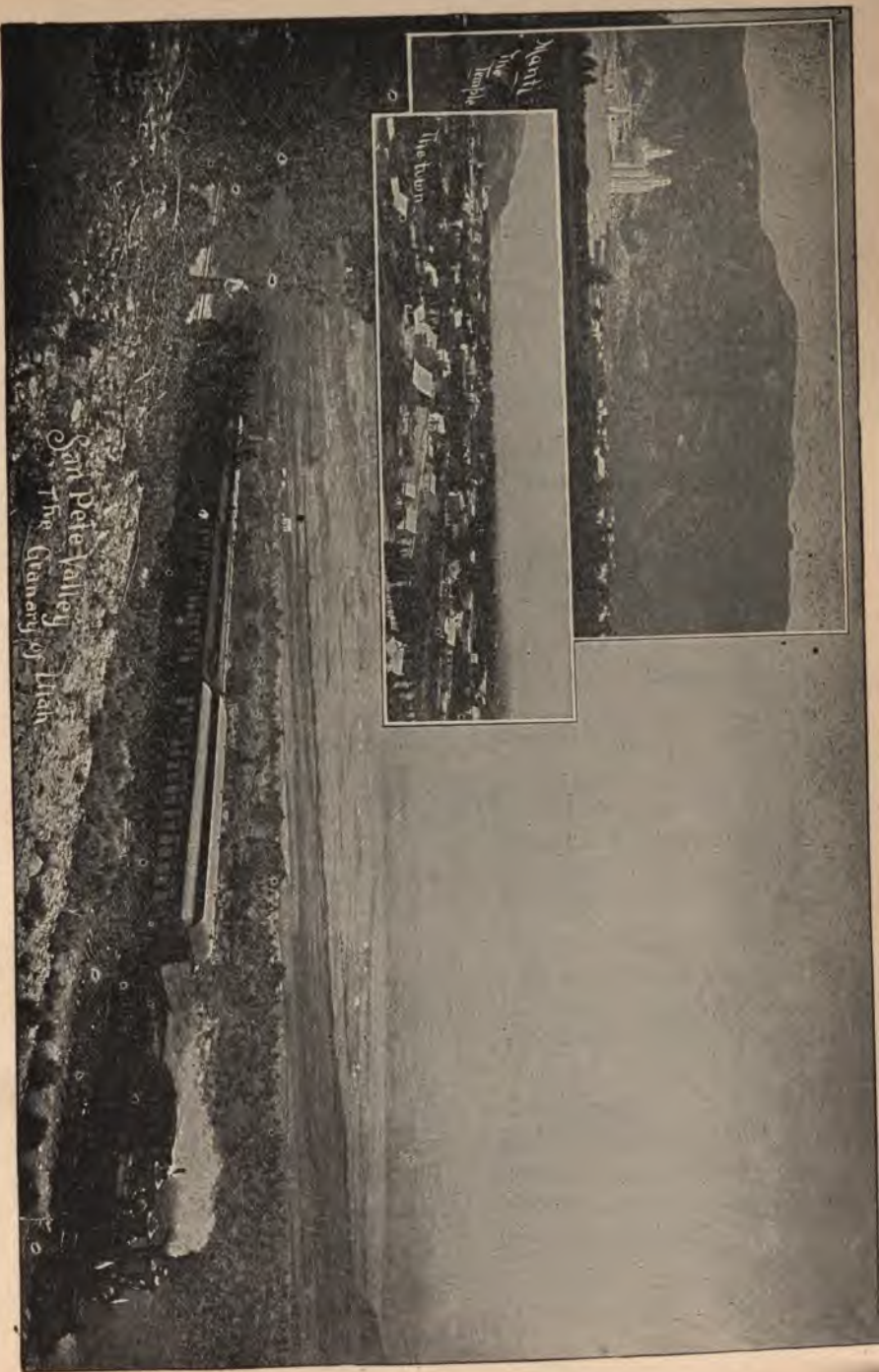
As will be seen there are only a few square miles in Utah that do not require irrigation. The system of cultivating the soil in Utah is to start canals at the mouth of the canyons, where dams are built. These canals are run from the canyons out upon the more level land of the valleys and there subdivided into branch canals, and these again divided into laterals leading to every farm so long as there is water to be distributed. Each farmer has canals leading from the main one to every field, and generally along the whole length of the upper side of each field. Each field has little furrows, a foot or more apart, and parallel with each other, running either lengthwise or crosswise or diagonally across as the slope of the land requires. Into these furrows the water is turned, one or more at a time, as the quantity of water permits, until it has flowed nearly to the other end, when it is turned into the next furrows, and so on until all are watered.

This is the usual custom, but where the soil is made of clay, this method is not so good and another is used. This method is to throw up little embankments six inches high around separate plats of land that are of uniform level, and turn the water in until the plat is full to the top, when the water is drawn off to the next lower plat and so on to the end. This enables the water to soak in more and so does the crop more good, but where the soil is porous, as is generally the case, it is not so good a method, as it wastes water. Each farm generally has the right to use the water so many hours once a week, or once in 10, 12 or 14 days, as the particular valley and the time of the year require. The crops are supposed to get a good soaking at every watering. The amount of land that each person can cultivate depends upon the quantity of water right that he owns. The method of dividing the water depends upon the intelligence of the farmers; in some places it is very crude, in others it is thorough. In few places is any entitled to a certain number of cubic feet per second. Generally each man has a right to such a portion of the water in a certain stream or river; if the season is a dry one he gets less water, and if it is a wet one he gets plenty. He must govern the quantity of crops put in by what he thinks will be the water supply for the season.

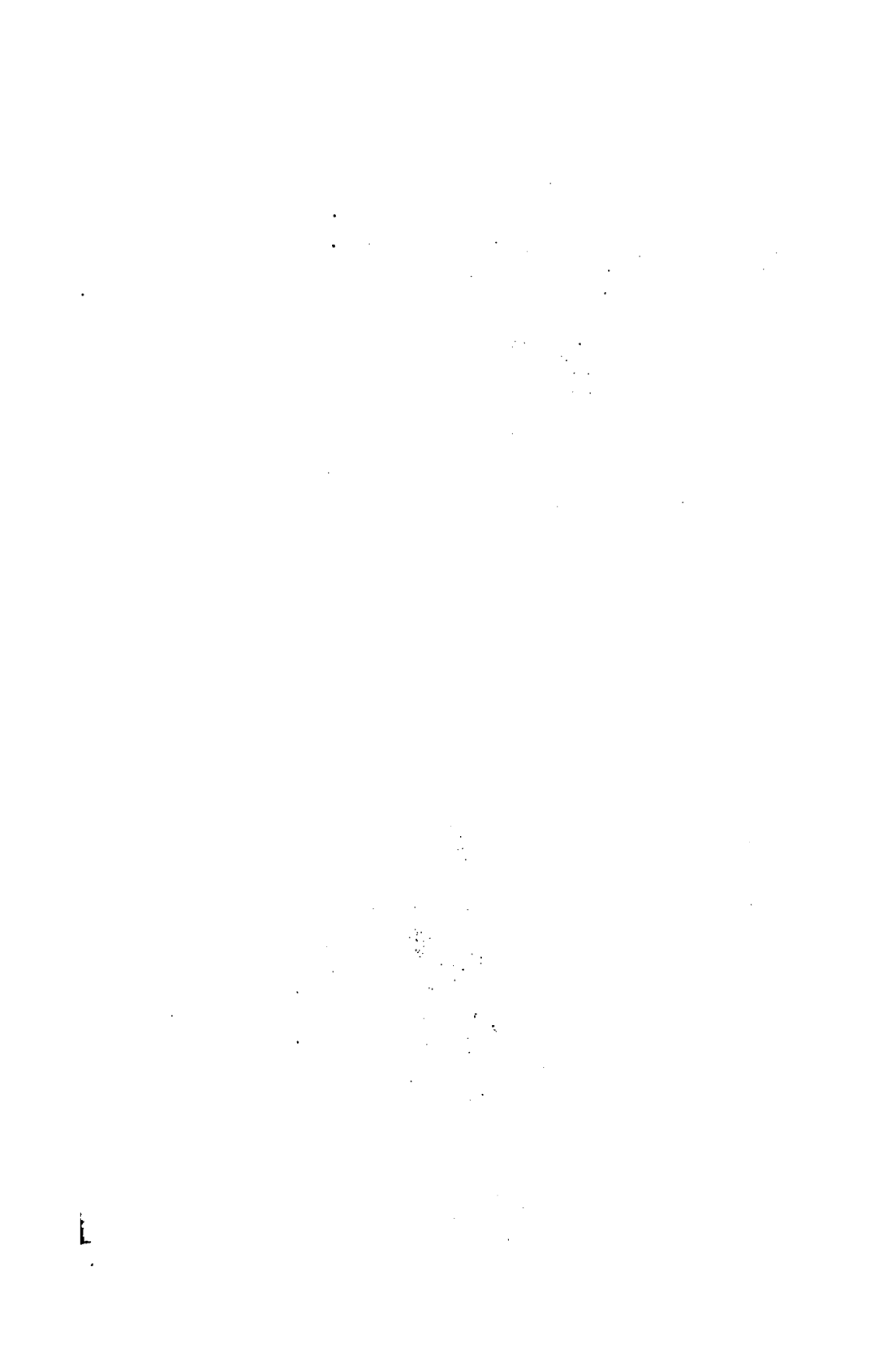
The method of dividing the water is to put in a dam at the head of the canal on the stream, with a partition in it separating the proper share for the canal, the rest being allowed to flow down the channel of the stream. The same method is used in the canal where people have certain shares in the stream at every new canal. Where the rights of people are based on a certain number of cubic feet per second, or miner's inches, there is a gate put in at every dam and lowered into the water till the water reaches a mark six inches above the bottom of the gate. This gate is raised or lowered as the quantity of water requires to keep the quantity of water on that point on the gate. The length and width of the space below the gate are multiplied together, and the product is called so many miner's inches; generally forty-eight of these are considered equal to one cubic foot per second. This method is correct where there is no back water below the dam to interfere with the fall of the water. The partition is then put in at the proper place to give the owners their due share of water. This division is kept up until there is no water to distribute. Those people who have a secondary right get what is left after the primary rights are filled. The irrigation season generally begins in May or the first of June, and ends in August, and is about 120 days long. The amount of land that one cubic foot of water can irrigate, ranges from thirty-five acres in the very hot and sandy country in the south, to one hundred and fifty acres in the higher valleys. The average is about one cubic foot to one hundred acres. The future growth in agriculture depends upon the storage of water in reservoirs, and above all, in the economical use of the water we have.

Increased humidity has followed the settlement and cultivation of the Mississippi Valley prairies, and it is not unlikely that it is doing so in Utah, although there is not sufficient data as yet to determine in what degree.

The mean air pressure at Salt Lake City is 25.63 inches; water boils at 204.3 degrees. The prevailing winds are from the north-northwest, and the most windy months are March, July, August and September. The mean velocity of the winds during the entire year is $5\frac{1}{2}$ miles an hour. On the ocean it is 18; at Liverpool it is 13; at Toronto, 9; at Philadelphia, 11. The climate of Utah on the whole is not unlike that of northwestern Texas and New Mexico, and is agreeable except for a month or so in winter, and then the temperature seldom falls to zero or snow to a greater depth than a foot; and it soon melts away, although it sometimes affords a few days' sleighing. The spring opens early in March.



SCENE ON LINE OF DENVER & RIO GRANDE WESTERN RAILWAY.



REPORT OF THE
Irrigation Committee
OF THE TERRITORY OF UTAH

*To the Third National Irrigation Congress, Assembled at Denver,
Colorado, September 3-10, 1894.*

Compiled and Prepared under the auspices of the Polytechnic Society of Utah.

To the President and Members of the Convention:

Herewith the Territory of Utah, through its State Commission, begs leave to contribute its mite relative to some of the problems that confront them and other denizens of the great arid region of the West.

Utah has been appropriately termed "The Cradle of American Irrigation," and when the little band of Mormon pioneers nearly fifty years ago took out their first ditch to water that little patch of potatoes, upon which their hope of increase was centered, verily they builded better than they knew. Undaunted by the sneers and assertions of Bridger, then supposedly the best authority in the whole region, and who told Brigham Young that he would pay him a ten dollar gold piece for every ear of corn he could raise in Salt Lake Valley, they persevered to that final success which has made them rich and prosperous, and which success has become historical. Theirs was the beginning of what subsequently led up to the more and more scientific methods of the present; yet history would be without value, if its verdict wrested from the Mormons the credit of being the beginners of American Irrigation.

Thus it is, gentlemen, that from this seemingly unimportant beginning, we have gone on from good to better, in making use of the modest means at our command under a system of co-operation,

which has never had its counterpart in modern civilization. By this system, we have married the water to the land, for in Utah we have but few large corporations which simply convey and sell the water to the land owner, but the land owners are almost invariably the owners of the canals by association, and of the right to the water.

It is a noteworthy fact that the irrigation system of Utah differs in very many respects from any of the other states and territories. The original settlement of our lands and the construction of our canals and ditches were practically simultaneous. Fostered and encouraged by the dominant church, the original settlers, nearly all members of one faith, wisely adopted small holdings, though partially from necessity, it is true. As only comparatively small areas were at first watered, this brought about a multiplicity of small canals taken from the natural water courses at greatly increased cost for both construction and maintenance, while it occasioned the diversion from the streams of at least double the amount of water actually used for irrigating. That these wasteful methods have been in many cases modified under skillful supervision, we are aware, and doubtless more will be, and the general system may be said to have worked fairly well until within the past few years, when the increasing demand for water and irrigable lands has brought about conditions seriously endangering vested rights.

As early as 1888-9, it became manifest that the methods of the early years could no longer be profitably carried out. The system that had been so successful in cheaply bringing out the running waters on to contiguous land, because it required but little more than the labor the farmers themselves could furnish, would not apply. The available flowing waters had been appropriated by and the only additional waters obtainable from the streams must be saved by storage for lands more distant therefrom, and moreover, the land laws of the United States are not such as can or will secure to capital the necessary safeguards to protect their investments, and without large capital the construction work is not possible.

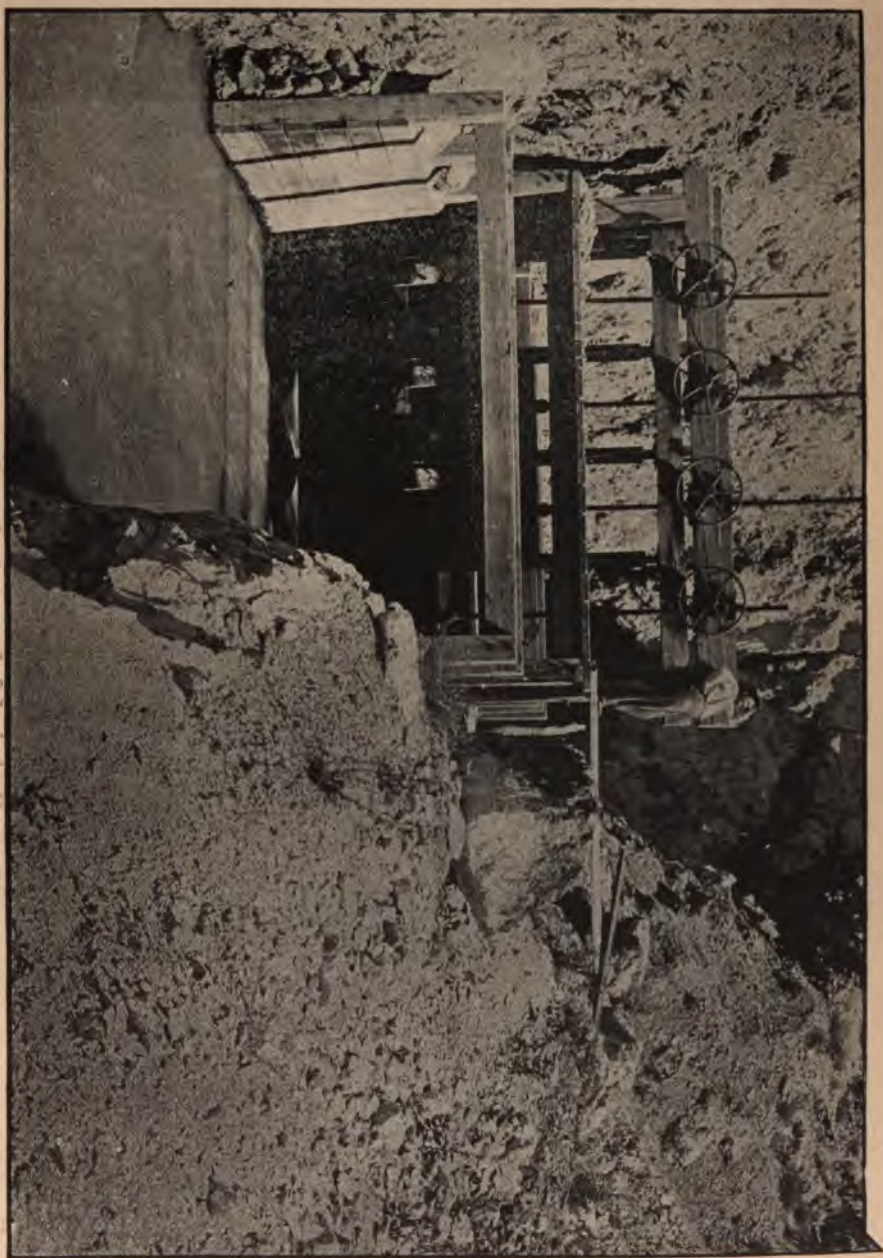
In varying degree other states and territories of the arid West were experiencing a like condition of affairs—it early became evident that with land laws that were not applicable to conditions undreamed of when such laws were framed, a convention of the states affected, to consider these facts and suggest remedies, was eminently proper and accordingly the first Irrigation Congress known in American history convened at Salt Lake City, September 15th, 1891.

The call for this assemblage was sent out by Governor Arthur L. Thomas, who, in his speech of welcome to the delegates made use of the following most pertinent words. "When the question of calling an Irrigation Congress was first discussed, it seemed to me there would be a special fairness in holding it in the Great Salt Lake Valley, where, in 1847, the cultivation of the soil by irrigation was commenced by the Mormon settlement, and where, upon success or failure, depended the life or death of the country as a place of human habitation. It was fitting, therefore, in a business as well as historic sense, that the first great Congress held by the western people to consider the important subject of irrigation, should assemble in Salt Lake Valley in Utah. This Congress is called for the purpose of hastening the reclamation of the arable arid land, so far as possible, and for the purpose of petitioning Congress to cede to the states and territories the arid lands within their borders, for the purpose; first, of reclaiming the same; second, in aid of the public schools; and third, for such other public purposes as the Legislative Assemblies of the states and territories may respectively determine." Pending the call for the Congress, one of the first acts of the Governor and the Congressional Committee was the appointing of a committee on irrigation statistics. It was in the absence of any Territorial Engineer or irrigation bureau, the nearest approach to an official investigation that could then be devised. At the outset the members of this committee felt that whatever was done must be done in a manner much more exhaustive than had ever before been attempted. The time was very short and a paucity of money at their disposal. It was immediately determined to avail themselves of the very per-

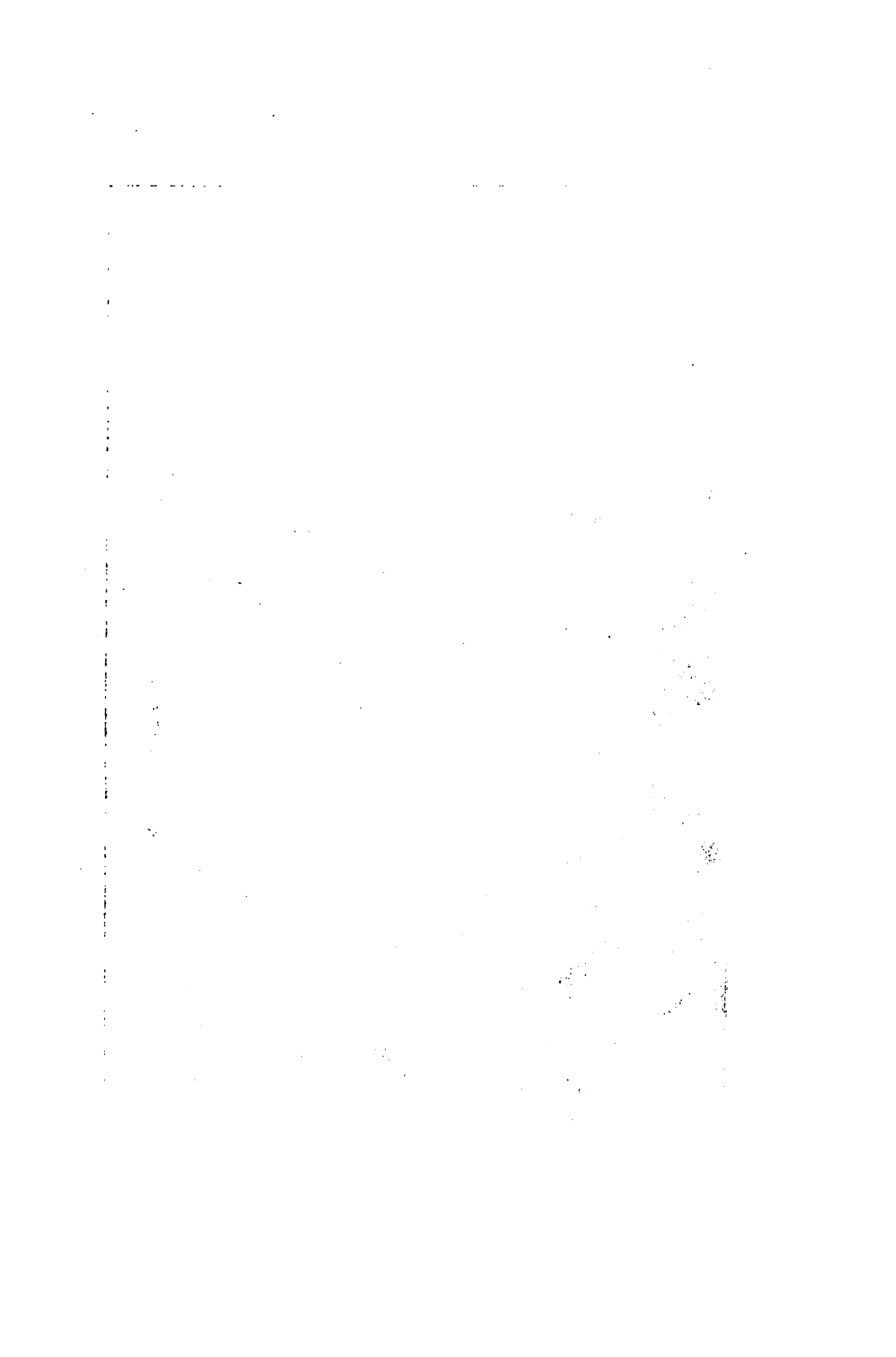
fect machinery of the Mormon Church, and they at once received the cordial co-operation of the officers of that body. They then sent out a series of questions to every president of stakes and bishop of wards throughout the Territory, also to County Assessors and Surveyors and committee delegates from Utah, also special letters were sent to private individuals and companies who were owners or had been engaged in the construction of important canals and other works in the Territory. They believed the farmers and owners of ditches could tell us what they owned and used, and in this belief were not mistaken. Their investigations showed that 423,364 acres of land were cultivated, that 735,226 acres were then under irrigation ditches, and the total acreage of irrigable lands in the Territory was 2,304,000, and that in 1891 there remained as susceptible of irrigation, and for which there was a sufficiency of water, 1,568,744 acres. The investigation further shows that of the appropriated waters the average waste was about 70 per cent.

It may be well to here state, but as will be more fully set forth herein, that the recent enabling Act granting statehood to Utah, cedes to the new state just about one and one-half million acres of arable lands for certain special purposes. The title to those lands is outright to the State, conditioned only that the income therefrom shall be applied strictly as mentioned; hence the treasury of Utah or those of its public institutions will be the recipients of all monies from public land sales or leases instead of that of the United States as at present.

The irrigation statistics of Utah as revised by our commission are presented to Congress in tabular form and in a manner that requires no detailed explanation. Since these were compiled in 1891, irrigation has been inaugurated to cover some 300,000 acres, in addition to those given, notably the modern and more scientifically constructed works of the Bear River, Swan Lake and Beaver Lake constructions, so that to-day there is in Utah, outside of Indian and Government reservation approximately 1,250,000 acres of lands susceptible of irrigation and for which, with storage and more conservative construction and management, there is a sufficiency of water.



CHUCK GATES BEAR RIVER IRRIGATION CANAL, UTAH.



Irrigation Statistics of Utah.

COMPILED 1891

REVISED 1894

BY

CHARLES L. STEVENSON, Irrigation Engineer,

Secretary of Utah Irrigation Commission.

IRRIGATION STATISTICS OF UTAH. (Prepared for Irrigation Congress, September 15th, 1891.)

COUNTY.	Acres under Irrigation	Acres actually irrigated 1890.	Acres cultivated 1890.	Total Acres Irrigable Lands in Territory.	Irrigation Season begins.	Irrigation Season ends.	No. of Times Lands irrigated during Season.	No. of Hours Land is irrigated each Time.	Elevation above Sea in feet.	Depth of Snow in Adjacent Mountains in Feet.	Unit of Water per cubic foot per second.
Beaver	9,000	6,850	6,350	Total acreage of Irrigable Lands in Territory, 2,304,000 acres. (Time insufficient to make county divisions.)	May 15	Aug. 15	8	24	5,000 to 6,000	4 feet	..
Box Elder	120,695	9,708	26,177		May	Aug.	8	1 1/2	4,000 to 5,000	3 "	..
Cache	66,654	30,951	54,301		May	Sept.	8	4	4,500	3 "	150
Davis	19,530	10,591	23,161		April	Oct.	10	2 1/2	4,200 to 5,000	3 "	..
Emery	23,415	13,062	14,363		March	Nov.	..	..	3,900 to 4,500	4 "	..
Grand	23,415	1,375	1,416		April 15	Oct. 1	..	..	5,800 to 6,300	..	..
Garfield	12,029	7,635	8,635		April	August	8	5	6,500	3 "	..
Iron	8,197	3,956	4,523		April	Nov.	6	6	5,000 to 6,000	4 "	80
Juab	8,100	4,914	9,489		May	Sept.	10	..	5,500	8 "	..
Kane	1,463	722	1,087		April 1	Oct.	8	12	5,500	..	75
Millard	88,586	8,152	8,152	Total acreage of Irrigable Lands in Territory, 2,304,000 acres. (Time insufficient to make county divisions.)	April 15	Aug. 15	..	..	5,500	3 "	..
Morgan	7,924	5,633	5,633		May 20	Sept. 1	7	..	4,000 to 5,000	6 "	100
Piute	17,172	9,918	9,918		April	Sept.	5	8	5,000 to 7,000	4 "	..
Rich	31,484	26,099	26,099		April	August	3	3	6,000	5 "	..
Salt Lake	53,086	29,107	30,555		May 15	Sept. 15	8	..	4,300	6 "	100
San Juan	1,107	927	927		..	..	..	..	5,000	..	..
Sanpete	45,102	33,859	47,113		May 15	Sept.	5	24	5,550	6 "	95
Sevier	29,106	15,340	15,340		April	Oct.	5	1	4,000 to 7,000	..	..
Summit	18,743	14,550	14,550		May	Sept.	3	..	5,845	5 "	..
Tooele	14,400	5,343	7,524		March	Sept.	..	..	4,600	2 "	80
Uintah	17,826	10,054	10,054	Total additional acreage susceptible of irrigation is 1,568,774	April	Oct.	..	..	4,600	6 "	..
Utah	79,380	53,586	60,520		March	Sept.	8	..	4,600	4 "	..
Washington	9,533	4,203	4,203		April	Oct.	12	3	2,700 to 5,000	4 "	40
Weber	33,344	17,204	22,450		May	Oct.	12	2	4,500	2 "	..
Wasatch	19,350	10,365	10,824		..	..	..	..	6,000 to 7,500	6 "	..
Total,	735,226	333,404	423,364								

NOTE.—The total acreage of Irrigable Land in Utah Territory 2,304,000
The total acreage covered by present ditches is - 735,226
The total additional acreage susceptible of irrigation is 1,568,774

STATISTICS OF 1894.—SUMMARY.

The total acreage of irrigable lands in Utah outside of present reservations,.....	2,304,000
The total acreage of irrigable lands in Utah inside of present reservations,.....	1,350,000
	<hr/> 3,654,000
The total acreage covered by present ditches is	1,035,226
The total additional acreage susceptible of irrigation and for which water can be had is	<hr/> 2,518,774

UNITED STATES LAND OFFICE RETURNS.

Salt Lake City, Utah, 1891.

No. of acres entered under Desert Land Laws,.....	694,165
No. of acres on which the final papers have issued, under Desert Land Laws,.....	135,340
No. of acres entered under the Timber Culture Laws,...	179,118
No. of acres entered under the Homestead Laws,.....	1,293,750
No. of acres on which cash certificates have issued,.....	<hr/> 375,791
No. of acres entered under all headings,.....	2,542,836
Estimated number of acres of surveyed land still subject to entry under the public land laws,.....	6,919,840
Estimated No. of acres of surveyed land subject to entry,	26,882,853

**ESTIMATED NUMBER OF ACRES OF LAND IN EACH COUNTY
SUBJECT TO ENTRY.**

NO.	COUNTY.	ACRES SURVEYED.	ACRES UNSURVEYED.
1	Beaver,	335,160	1,700,000
2	Box Elder,	483,316	1,906,960
3	Cache,	90,740	95,668
4	Davis,	9,367	700,000
5	Emery,	448,165	2,300,000
6	Garfield,	214,500	2,300,000
7	Iron,	582,250	1,920,000
8	Juab,	707,920	1,500,000
9	Kane,	377,580	1,610,000
10	Millard,	1,191,590	2,500,000
11	Morgan,	51,080	500,000
12	Piute,	220,880	1,380,000
13	Rich,	289,880	7,000
14	Salt Lake,	2,700	130,000
15	Sanpete,	122,680	860,000
16	Sevier,	211,100	1,460,000
17	Summit,	217,500	1,000,000
18	Tooele,	769,220.	2,500,000
19	Uintah,	150,540	1,644,000
20	Utah,	182,677	1,000,000
21	Wasatch,	62,155	207,000
22	Washington,	188,340	1,000,000
23	Weber,	8,500	290,519
Total,		6,919,840	28,511,147

The following gives the average annual precipitation at prominent points, north, east, south and west of Salt Lake City:

STATION.	DURATION OF OBSERVATIONS.	AVERAGE ANNUAL PRECIPITATION.
Kelton,	12 years.	6.10 inches.
Ogden,	21 "	13.46 "
Coalville,	10 "	13.74 "
Fort Duchesne,	3 "	6.53 "
Fort Douglas,	9 "	17.41 "
Deep Creek,	3 "	5.18 "

MONTHLY AND ANNUAL PRECIPITATION AT SALT LAKE CITY, UTAH, FROM RETURNS
U. S. SIGNAL OFFICE, WAR DEPARTMENT.

Year.	Jan.	Feb.	March.	April.	May.	June	July	August	Sept.	Oct.	Nov.	Dec.	Annual.
1857.	.	0.85	0.97	0.19	0.83	1.00	0.64	0.85	0.58	1.00	.	.	.
1858.	.	.	.	.	.	.	.	.	0.15	3.28	.	.	.
1859.	0.65	3.88	3.33	1.43	1.85	0.11	.	0.13	1.58	0.22	3.85	0.70	.
1861.	1.40	2.13	2.49	1.47	1.10	.	1.57	1.47	3.01	.	1.76	2.13	.
1863.	.	2.74	.	.	.	0.30	.	.	.	.	.	.	.
1864.	3.28	0.86	2.94	1.37	1.96	1.50	0.00	1.25	0.73	3.75	1.19	5.04	23.87
1865.	1.22	3.72	2.38	0.54	0.26	0.70	1.75	0.62	1.52	3.15	0.62	6.39	22.67
1866.	1.83	1.60	2.72	3.34	2.05	5.34	8.73	1.98	2.05	1.80	2.20	4.56	38.20
1867.	.	1.75	.	.	.	1.47	2.61	9.43	1.07	1.41	.	3.65	.
1868.	64	.	.	.	2.43	4.00	.	3.69	.	.	.	.	.
1872.	.	.	.	.	2.50	3.90	0.00	1.56	0.54	1.01	0.90	1.90	.
1873.	3.65	5.60	1.60	1.25	10.05	0.85	0.60	4.75	1.00	1.60	1.00	1.00	32.95
1874.	.	.	1.31	0.90	2.84	0.74	2.42	1.63	0.20	1.74	2.16	0.73	.
1875.	3.05	0.79	2.81	1.50	2.91	0.90	0.83	0.25	1.22	1.36	5.81	2.03	23.64
1876.	1.23	1.52	4.00	2.09	4.30	0.09	0.80	0.92	0.42	3.27	0.81	1.80	21.28
1877.	0.87	0.38	2.93	2.14	3.49	0.80	0.02	0.28	0.90	2.41	1.02	1.11	16.35
1878.	1.07	3.49	2.54	2.63	2.50	0.35	1.08	0.81	3.15	1.39	0.63	0.11	19.75
1879.	1.87	0.71	0.67	3.26	0.10	1.34	0.07	0.06	0.01	1.62	0.32	3.08	13.11
1880.	0.29	1.02	0.43	2.37	1.85	0.01	0.20	0.74	0.56	0.40	1.17	1.90	10.94
1881.	1.24	2.44	0.88	2.37	2.55	0.08	0.21	1.61	0.43	2.19	1.44	1.24	16.88
1882.	1.50	0.42	1.12	3.81	0.26	2.24	0.30	1.61	0.37	2.89	0.54	0.92	15.98
1883.	1.47	0.72	1.75	2.92	0.98	0.33	0.10	0.62	0.13	2.24	1.78	2.12	17.52
1884.	0.71	2.23	3.69	2.89	1.78	0.33	0.27	0.73	1.91	0.36	0.50	0.92	21.60
1885.	1.48	1.56	2.64	3.47	2.49	2.67	0.58	0.90	1.29	0.59	3.10	0.92	18.89
1886.	1.91	1.36	2.60	4.43	0.66	1.02	T	0.59	1.88	1.98	1.79	1.27	11.66
1887.	2.36	1.41	0.35	1.87	0.73	0.37	1.23	0.69	0.55	0.30	0.45	1.55	13.62
1888.	1.52	1.22	1.18	0.99	0.34	0.98	0.24	0.63	0.51	0.80	2.00	2.21	18.46
1889.	0.73	0.81	1.64	1.52	2.97	0.01	0.08	0.92	0.52	3.85	1.04	4.37	.
1890.	3.07	2.05	1.12	0.74	0.58	0.32	.	.	.	.	.	.	.
Means	1.52	1.38	1.92	2.35	1.81	0.75	0.54	0.81	0.88	1.71	1.52	1.66	16.85

A very recent Act of the United States Congress has arranged for throwing open to public settlement of some 3,000,000 acres from Indian reservations in the eastern part of Utah. Of this 3,000,000 acres it is estimated that 45 per cent, or 1,350,000 acres can be irrigated; so that the present condition of lands in Utah is that there remains some 2,500,000 acres susceptible of irrigation over and above those now covered. Deducting from these the lands recently ceded to the State, (1,500,000) and there will remain approximately 1,000,000 acres of U. S. Government lands within the borders of Utah susceptible of irrigation from present known sources.

It will thus be seen that the special interest which Utah has in the disposition of the public lands within its boundaries is but small at best, and by comparison with its neighbors sinks into insignificance, for this reason the commission as a whole will not undertake to formulate any special enactments, either National or State, though some of the delegates from Utah will present suggestions on both these lines, and those on the special subject of forestry. The Commission cannot but feel that our State requirements are limited by comparison and that the legislation which would cover these requirements would be inoperative for other states. They will, however, endeavor as briefly as possible to outline what they believe should be the National policy concerning the disposition of the public lands and thereby express the unanimous sentiment of the people of Utah as recently evoked.

The first Congress held in Salt Lake City in 1891, adopted a platform favoring the cession of arid lands to the various states. The Utah Legislature, 1891-2, memorialized Congress, endorsing the plan.

The Los Angeles Congress, held in September, 1893, adopted a platform or address to the public of the United States, giving the views of the Congress concerning needed legislation to secure the more rapid and successful reclamation of the arid lands; and it also formulated certain principles concerning irrigation law which were departures from those now existing.

To obtain the views of the people of Utah on all these mooted

points, an address was sent out to them, containing the following queries. Their verdict will be found in the conclusions hereinafter given, as well as the very strong reasons that led up to them.

The first Irrigation Congress, held at Salt Lake City, 1891, decided that the best results for the reclamation of the arid lands would be secured by the cession of such public lands to the state, and the control and sale thereof be exercised by that state.

5th. Question of Commission. Do you favor any change in the policy decided upon at the Salt Lake Congress of 1891 and endorsed by the Legislature of Utah? If so, in what particular or manner?

The platform of the Irrigation Congress held at Los Angeles in 1893, favored several departures from existing laws. We submit these inquiries in relation thereto as follows:

First. The Irrigation Congress declares—"We declare that water in natural channels and beds is public property, and when under the law of any state vested rights have been secured thereto, such rights, like all other private property, may be supervised for beneficial purposes, and be condemned for public use, under the exercise of the power of eminent domain."

6th. Do you favor the principle of condemning existing water rights?

The Los Angeles platform declares—"We declare that all streams rising in one state and flowing by natural courses through one or more other states, must be conserved and equally divided under Federal authority."

7th. Do you favor the division of the water among appropriators by officers of the general government rather than local officers?

Third. The Los Angeles platform declares—"We favor the limitation of the amount of land that may be taken up by the settlers, under systems of irrigation, to forty acres, and predict that in the future it will be found desirable to reduce the amount still further, and we favor the restriction of the privilege of taking up public lands to citizens of the United States."

8th. Does the limitation of land filings to forty acres, meet your approval?

When the Salt Lake platform was so unanimously adopted, it was very generally supposed here in the West, that the more favored states of the East would say, as a recent writer puts it, "Take your worthless arid lands and get out;" but when the matter came to be formally discussed in and out of the United States Congress, and in the public press, there suddenly arose an opposition.

The lands, they said, were an inheritance of all the people, and the National Government had no right to cede them—that their great value when reclaimed had been proven, and that it would be unjust to deprive them of the proceeds of the sales which they were entitled to, and which they have for so many years been receiving. Yet the West has never received a tithe of the vast sums which the older states have in a thousand and one ways been paid.

Since the U. S. land office has been established in Utah, some six millions of dollars have been paid into the U. S. Treasury for public lands sold in that territory. How much of this has crept back into the treasury of Utah? The great bulk of all land sales has inured in many ways to the older and vastly less needy states.

So manifestly unequal were these conditions, that over a year ago, the then governor of Utah, Arthur L. Thomas, prepared a most able showing of the amounts the Government has paid out in promoting the nation's welfare. So carefully drawn are these statistics of the past and the conclusions as to the future national policy, that we here repeat a portion, since they apply in a vastly greater degree to the whole of the arid West, than to Utah alone. We further believe that the publication of these figures at this time and by so appropriate a body as this Congress, will be of marked benefit. We quote as follows, leaving out the detail of amounts received by each state, by railway corporations, etc.:

"The proposition to cede the lands has evoked considerable opposition, principally from the people of the East. Some have

very broadly asserted the Government has not the right to cede these lands, while others claim that if the right does exist, the people of other sections have a common interest in the lands and the proceeds of the sales, and it would be unjust to deprive them of it. Others base their opposition on purely selfish grounds. A gathering of farmers held in the state of New York adopted a resolution protesting against the cession on the ground that to increase the area of tillable land would be injurious to existing agricultural interests. A New England paper opposed it because it would increase the evaporating-surface of the United States by one-half, and this it feared would cause New England to become as cold as Alaska.

A reference to the proceedings of the Congress of the Confederation and the laws passed by Congress may serve to show how far the claims made for and against the proposition are justified by the facts.

DONATIONS TO THE ORIGINAL STATES.

When the colonies declared their independence of Great Britain, the boundaries of many were very indefinite, and the rights which they succeeded to undetermined. The claim was made that the moment that the declaration was given to the world they became free, sovereign and independent states, and as such, succeeded to all the rights, privileges and immunities ever enjoyed, and to all the land ever owned by the Crown within their boundaries. Because of this claim, the extent of the boundaries was a matter of great importance. In the case of Virginia it was vigorously claimed its western boundary reached to the Mississippi, and in the case of New York and Pennsylvania, far out into the "back country," out of which was subsequently organized the great Northwestern Territory.

The disputed boundaries were finally settled, and the title to nearly all public lands within the boundaries of the original states

passed to the states respectively. New York at that time received over seven million acres of land. Massachusetts retained much of her possessions or wild lands, in what is now known as the State of Maine. Within a recent period public land was sold by the State of Pennsylvania and the proceeds covered into the general treasury. Thus, at the beginning these states were magnificently endowed with public lands. Who can measure the extent of the benefits received by their citizens from this endowment? They have indirectly received other substantial benefits from public lands. The proceeds of the sales of the lands, amounting to many hundreds of millions of dollars were covered into their treasury, and used in common with other public funds in making public improvements, in these as well as other states. The appropriation for rivers and harbors and other purposes will show this very clearly.

The total amount appropriated for rivers and harbors from 1789 to 1883 was \$111,299,464.79.

Of all these millions but \$2,781,000 was expended in the vast tract of country embracing the arid region and the Pacific coast states. The same great disparity exists in the appropriations made for public buildings and other public improvements.

The appropriation for public buildings from March 4th, 1789 to June 30th, 1882, were \$89,159,795.03.

Of the miscellaneous appropriations, there is no evidence that one dollar was expended west of the Missouri; if so, it was only for furniture, etc., and amounted to but very little.

The amount appropriated to states and territories for roads and canals, 1879 to 1882 was \$19,891,943.35.

Of the miscellaneous, bridge and canal appropriations, all but \$1,275,604.54 were expended east of the Missouri river, excepting \$120,000 expended in making a survey across the Isthmus of Darien and for the Nicaraguan canal.

GRANTS FOR INTERNAL IMPROVEMENTS.

The first Acts granting lands in aid of internal improvements became laws on April 30th, 1802, and March, 1803. These grants were for the purpose of laying out public roads leading to the Ohio river. Other grants were made from time to time. From 1850 to June 30th, 1892, 1,782,730 acres were granted to aid in the construction of wagon roads.

On March 2nd, 1827, lands were granted to the states of Illinois and Indiana to aid in the construction of a canal leading from the Wabash river to Lake Erie, and from the Illinois river to Lake Michigan. At the same time a grant of land was made to aid in the construction of a road leading from Sandusky to Columbus. In 1828, Ohio received a grant in aid of the construction of a canal (Miami) leading from Dayton to Lake Erie.

The total grant of lands to states for canal purposes from 1824 to June 20th, 1892, was 4,424,073 acres.

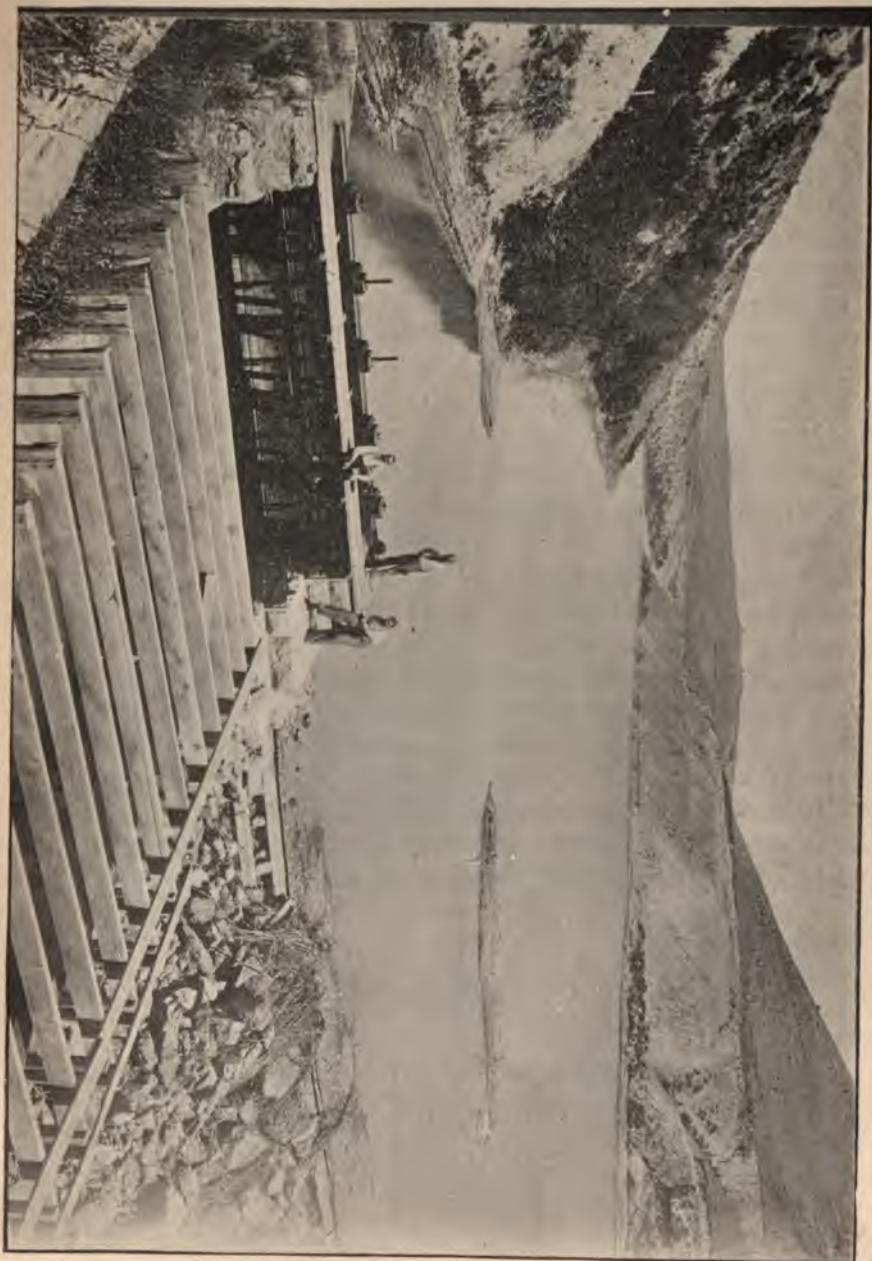
For river improvements there were granted during the same period to three states east of the Missouri river, 1,406,210 acres.

On March 2nd, 1833, the first act was passed granting lands in aid of the construction of a railroad. It was to be built in the state of Illinois. Up to June 30th, 1892, the total grants of land patented in the states for railroad purposes was 37,713,978 acres.

Of the total granted directly to railway corporations there was patented up to June 30, 1892, of surveyed lands, 19,456,674 acres. The total acreage for canals, river improvements to states and to railways directly was therefore 64,783,761. This does not include the railway grants not yet patented.

GRANTS FOR SCHOOLS.

The total amount of the grants of public lands for educational purposes was to 1873, about 80,000,000 acres.



HEAD GATES, BEAR RIVER IRRIGATION COMPANY, UTAH.



SALINE LANDS.

By the Act of May 18th, 1796, saline springs and lands adjoining within certain prescribed limits were reserved by the National Government. The acts of admission of fourteen of the states gave these lands to the states. The amounts given to them were 559,965 acres.

GRANTS OF SWAMP LANDS.

The first attempt to obtain from the Government a cession of the swamp lands was made in 1833. Missouri and Illinois asked for the lands within their respective limits. On March 3rd, 1849, Louisiana was granted to aid "in constructing the necessary levees and drains to reclaim the swamps and overflowed lands therein, the whole of those swamps and overflowed lands which may be, or are found unfit for cultivation." On September 28th, 1850, Arkansas was given a similar grant for like purposes. The last section of the law making the Arkansas grant, provided that the benefits of the act should apply to "each of the other states of the Union in which such swamp and overflowed lands, known and designated as aforesaid, may be situated."

Under this law the total number of acres selected by the various states up to June 30, 1892 was 80,271,541 acres.

Of the lands thus selected patents have issued for 57,793,545 acres.

FINANCIAL AID.

In addition to the vast donations of lands made for internal improvements, education and the reclamation of swamp lands, etc., Congress in 1836 distributed among the states from the surplus in the treasury, over \$42,000,000.

This gives a total granted in money of \$262,351,152, and of acres, 225,615,171.

Now these facts and figures show very clearly how great has been the aid in money and land the older states have received. They further show that Congress has always exercised the right of disposing of the public lands for the public benefit, and in aid of private and public enterprises whenever, in its judgment, the public interests could be served.

The swamp lands were granted *for reclamation*. It was urged in Congress such action would bring large areas of worthless land under cultivation, and give homes to thousands. The argument applies with equal if not greater force to the cession of the arid lands, and the claim that Congress has no right to cede must give way before the many precedents to the contrary.

In support of the justice and the public policy of the cession it can be urged that the reclamation of fertile arid lands will prove to be of great public benefit, and contribute to the support of a large population. There is but little public land remaining, subject to entry, cultivable without irrigation. To get water requires an expenditure far beyond the means of the settler. The limit of successful settlement in the arid region, by the pioneer methods, is about reached. Further settlement will depend upon the adoption of extensive and costly methods.

If the anticipated benefits were sufficient to justify Congress in aiding in the reclamation of swamp lands, why are not like benefits which will follow the reclamation of rich arid lands, equally so?

If it was right and proper to grant an empire of land and millions of dollars to build a transcontinental line to promote the settlement of the West, will it not be equally so to use the proceeds of the unproductive to increase the area of productive lands of the same region?

The claim that all the people have a common interest in these lands is correct. But the people of the East have long received the benefits of appropriations of public money, much of it derived from the sales of public lands, and have in so many ways enjoyed

the bounty of the Government, so much more in proportion to the population than the people of the West can ever expect to receive, that it is reasonable to suppose that Congress will rise above sectional prejudices and selfishness, and do justice to the enterprising and struggling communities of the West. It will consider the hardships incident to the settlement of these remoter regions of our country; that it requires more time, money and labor to establish settlements in a region where location must depend upon the water supply, than it does where national conditions are favorable, and convenient to railways, rivers, etc.

Stress is laid upon the great value of the lands to be ceded, but with little reason. If the Government will hereafter give the states and territories of the arid region the proceeds of all sales of public lands within their borders, the total amount received would not equal one-quarter of the value of the school lands alone, given to the states east of the arid region, without considering other grants of lands and money.

The matter of revenue is worthy of consideration. So long as they belong to the Government, and under the present system the great proportion always will, the public lands cannot be taxed. This leaves the burden of local government to be borne by settlers upon a very limited area. In Utah about four per cent. of the whole.

The scattered settlements of the arid region are surrounded by vast areas of mountain and plain, chiefly valuable for their sparse natural forage, and this value is rapidly depreciating, because of unsatisfactory conditions attending their use. Unless some way is soon provided to permit stock raisers to acquire title to tracts sufficiently large to graze their animals, and thus cause them to feel an interest in preserving the forage plants, it is only a question of a little time when their chief value will be completely destroyed. This would materially affect the food supply, and be keenly felt.

To reclaim more of the arid lands will require considerable capital. The natural flow of the streams is nearly all appropriated, and to obtain water in the irrigating season, it will have to be

stored in large and costly reservoirs in the season when the flow is the largest and unused. Canals, running long distances, and in many cases, dams and other appurtenances, must be constructed before the water can be spread over the land. The settler is not able to do this. To reclaim the land, he must have aid. The Government will not grant it in money and the only practicable thing to do is to give the lands to be used for the purposes mentioned. Upon such action will ultimately depend the complete settlement of the West.

From the past history of the United States, it is clear that the public policy has been to be most liberal in its dealings with the several states, and we think that any cessions of lands hereafter should be as free from Congressional conditions as possible.

Practically, in the matter of dealing with the sale of the public lands heretofore, the Government has been the agent and trustee of the people, and we believe the time has arrived when this agency can be entrusted to the arid states for the lands within their confines.

That as to state enactments no general laws can now be well framed, the better way would be to leave the matter to be dealt with by the local legislatures. They will better understand how to act, than others will know how to act for them. If the attempt is made in any general act to go into special provisions in regard to the means of reclamation, and the disposing of the lands, it will lead to complications, because of the different situations and local conditions of the states and territories.

We cannot but favorably construe the very liberal cessions to Utah and the still further grant of one million acres to each of the arid states for reclamation purposes, as showing that in agitating these questions, and through the action of irrigation congresses, great progress has been made.

We further believe that each state should also own and control its forest and pastoral lands. The very salvation of our irrigable supply depends upon the preserving of the forests at the head waters of our streams, whether from fire, the axe, or animals; and the grazing lands we certainly cannot afford to have destroyed by

over-stocking. Make the state the owner of these lands, so they may be sold or leased, and all the wrangles and contentions due to free range will soon settle themselves, while the state, even with an annual rental of two cents per acre, will find its treasury the better off by many thousands of dollars.

In the older states, and where the general government has long since ceased to own any salable lands, works of vast internal improvement are in constant course of construction, at the expense of the whole people of the United States.

Why is not the damming and improvement of some of our natural lakes to make them servicable to the public quite as much in the line of internal improvement as a levee on the banks of a river, or a breakwater at a harbor's mouth? We believe that the Government should, before or after ceding the lands, make such surveys as will determine the capacity and elevations of the streams and the areas of the lands, which they can be made to irrigate, with such other physical data as the requirements of utilization dictate.

The new constitution of the state of Utah will, so far as ownership of water is concerned, probably be framed on a similar basis to that of Colorado and Wyoming, with such needed changes as the operation of those constitutions most naturally suggest; but we believe that all vested rights that have accrued on any of the interstate rivers will be protected, but sincerely hope that this Congress will give this question all the grave consideration its importance demands.

As to the condemnation of vested rights to water, under the right of eminent domain, in our sixth question to the people of Utah. The general opinion is that all such matters are proper for the state legislatures to settle.

They further believe that local legislatures will be found more competent to enact irrigation laws than Congress, and which laws will not only protect vested rights but will give to old and new canal companies that protection which is denied them by the present land laws.

The people of Utah are practically unanimous in preferring

that all divisions of water among appropriators should be by local officers entirely.

They also believe that the limiting of land filings to forty acres is properly a matter for local state legislation.

In conclusion we sincerely believe that with united and untiring effort, there will be results attained by this Congress which even if not final will go far to settle all the vexed arid land problems of the present.

MEMBERS OF THE COMMISSION FOR UTAH.

W. H. ROWE,

Member of the National Executive Committee.

S. FORTIER, Logan.

L. W. SHURTLIFF, Ogden.

L. HOLBROOK, Provo.

C. E. WANTLAND, Salt Lake City.

C. W. ALDRACH, Millard County.

C. L. STEVENSON, Secretary, Salt Lake City.





WILFORD WOODRUFF, PRESIDENT MORMON CHURCH.



HON. GEORGE Q. CANNON.



GENERAL PLAN OF THE DISTRICT OF COLUMBIA



GENERAL PLAN OF THE DISTRICT OF COLUMBIA

THE MORMON LAND SYSTEM IN UTAH.

*The Speech of the Hon. George Q. Cannon as Temporary Chairman
of the Third National Irrigation Congress.*

Ladies and Gentlemen of the Irrigation Congress:

I might say truthfully that this is somewhat unexpected to me. I received notice last night on my arrival after midnight at the hotel from the chairman of the National Committee that it was contemplated to put my name in nomination as a temporary chairman of this National Irrigation Congress. I almost hoped, and if it had not been for my pride in the territory from which I come, that some other name might have been substituted for mine, for in the midst of men like these who have gathered here to-day I submit that I feel a sense of modesty, and would rather sit and listen than take a prominent part in the proceedings of this congress. Nevertheless, it is probably due to Utah, in view of the attitude which she has occupied for the last forty-seven years on this great and important question, that she should occupy some prominent position in this congress.

Forty-seven years ago I crossed the plains in company with companions who were then seeking homes in the Far West. I did not occupy so prominent a position in the community as has been represented, because I was but a youth 20 years old, but I was then, as I am now, deeply interested in the future of this Western country. I felt that there was a great future for it, and then to me, as with all those who traveled at that time, it was so different to all the old conditions under which we lived that it

seemed like a new world. We entered Salt Lake Valley, that is, I and the party I accompanied, about eight weeks after the pioneers headed by Brigham Young had entered the valley. That band consisted of 143 men and three women. We followed them and traveled with women and children in considerable number, there being some 2,000 all told in the different companies.

THE LUXURY OF POTATOES.

The pioneers had already planted a few seeds and made some attempt at irrigation, but as they landed the latter part of July, (the 24th it was) it was very difficult to do anything except to preserve the seed. That seed was very carefully cared for and husbanded, and from that seed the seed potatoes (that was the first vegetable introduced into Utah) sprung. But it was not until 1849 that any of us, unless it was through curiosity, tasted potatoes. We preserved the seed so carefully that we did not dare to eat potatoes. In 1848, after planting our grains and vegetables, we found that to obtain the food we needed we could not depend upon rains, but would have to water the land from the streams, and as we did not have the scientific friends that we have with us now to do it in a scientific manner, we went at it as best we could, and took out water by the simplest means in our reach, and we were successful in raising at least a part of a crop. After our grain had been sown and our fields looked promising, black crickets came down by the millions and devoured our crops. I have seen fields of wheat look as promising as they could in the morning, and by evening they would be as bare as the palm of a man's hand—devoured by these crickets.

For a time it seemed that everything we had planted would be destroyed, and you can well imagine the precariousness of our position. California was on our west, 800 miles distant; to the east was no settlement nearer than the Des Moines river in Iowa, and a few settlements perhaps in upper Missouri, so that we were entirely dependent upon that food which we had brought in our wagons. That supply was so limited that we had to deal it out with the utmost care. Food was weighed by the ounce and limited

to every individual, and no one could eat more than his share of the allowance that was divided for the week's supply.

I was a growing boy then, and I had never worked so hard as we had to do then. My allowance of food, therefore, was not sufficient for my wants, and I was continually hungry during that winter. It seemed to me that I was hungry to the ends of toes and fingers. I was an orphan, but I lived with an uncle and aunt. My birthday came in mid-winter, and my aunt said to me on that day: "George, we will have all we can eat to-day, as it is your birthday. You invite your young friends to come in and partake with us." Until meal time, I looked forward with anticipation of having a good square dinner. I mention this little incident because it may be an interesting fact to some to know that a person can eat all that is possible at one meal and still be hungry. For I ate all I could, and I was hungry in ten minutes afterwards. The stomach, being contracted by having so small an amount of food, the system being starved, it required more than one meal to satisfy nature.

THISTLE TOPS AS FOOD.

When spring came the thistles began to grow in the neighborhood of our fields. Our oxen were thin, and we could only use them in plowing until about the middle of the afternoon. Then we would go around and gather thistle tops for greens. It is a fact that the distention of the stomach caused by eating these thistles allayed our hunger, and having milk, which our cows began to give freely, we soon grew fat.

The crickets, to which I have alluded to, destroyed a great many fields, and it seemed for a while that they would devour everything that was planted. I had no responsibility upon me, but I have often since thought of the wonderful courage which the men who had families depending upon them exhibited under these circumstances. I can recall no expressions of fear or discouragement. Every man appeared to feel that he would stay there, no matter what the consequences might be. But relief came to us; and to us who lived in Utah at that time it appeared like a

direct interposition of Providence to save us. Sea gulls came by hundreds and thousands, and before the crops were entirely destroyed, these gulls devoured the insects, so that our fields were entirely freed from them. Since then, whenever I see a boy pointing a gun at a gull, I feel that I want to knock his gun up. The bird has become sacred to me. Since then Salt Lake has become the habitat of this bird. After these gulls came, I have gone along our water ditches in the morning and have seen quantities of small piles of crickets which the gulls had eaten and vomited up. By disgorging themselves in this way, each bird must have devoured immense quantities.

The dryness of the country at that time was something dreadful. It seemed as though the land was dead. This was forcibly brought to my mind by seeing a grave dug soon after we reached the valley. The spot is now one of the most populous parts of Salt Lake City, and is very fertile, but at that time it seemed as though the ground had not been saturated for ages. One of the first ditches that was dug was taken out of the creek near where the large Co-operative store now stands, which some of you ladies and gentlemen who have visited Salt Lake may remember. This ditch was dug to convey the water to the fort, in which the people then lived, which was about half a mile distant, and the ground was so thirsty that it took two days for it to run that distance.

THE UTAH OF TO-DAY.

Great and happy results have followed the system of irrigation. I can say to-day that Utah is proud to have the opportunity of participating in a congress of this character. We feel that the questions to be brought before this congress are of the greatest importance, not only to this portion of America, but to the entire Union. Every man in this entire Republic ought to be interested in the questions which will be discussed, I hope, so freely and profitably in our congress. It is a matter which affects not only the West, but the East, and in fact it may be said to affect humanity, and everything should be done in our deliberations to reach united action, so that whatever we determine upon will be

acceptable to the whole people and to the Congress of the United States. I am glad that these deliberations are likely to take a wide scope. I would like to see every person take an interest in irrigation, whether he lives in the arid regions or the heaven-watered regions, and I hope every delegate will have the opportunity to express himself with the utmost freedom, that we may reach not only unity of sentiment, but unity of action.

We in Utah have proved that the small holdings are the best for the people. Our pioneers when they went into that country, arranged in the first place that men at the head of a household should receive a city lot. The city was divided into blocks of ten acres, containing eight lots of one and a quarter acres each. I remember applying for a lot and was told that I was not a married man and could not have the land. Outside the city the first lots were five-acre lots, later ten-acre lots, and later twenty-acre lots. Mechanics were each expected to draw at least five acres, and if their families were large enough, they could draw ten acres. It was not a law, but a regulation. These regulations were adopted so that no man should monopolize land. Every man in the community could have a sufficient quantity to enable him to raise what he wanted, but could have no land for speculation.

The people of Utah have been in dread of a tax for water. They do not think it is necessary. We have proved that water can be taken out and be used by the poor man without being taxed for it when the people are united and make a proper combination of effort. We have proved this, and also that large tracts of land are not necessary for the public good. In saying this I express the feeling of the people of Utah. But our conditions differ in many respects from those surrounding the people of California, Colorado, Arizona, and other parts of the arid regions. I do not wish, therefore, in making these remarks to be understood that we oppose the construction of large canals or other measures which may be deemed necessary in our neighboring states and territories. I only wish to say that we have proved that our system of taking out water by the co-operation of farmers who are

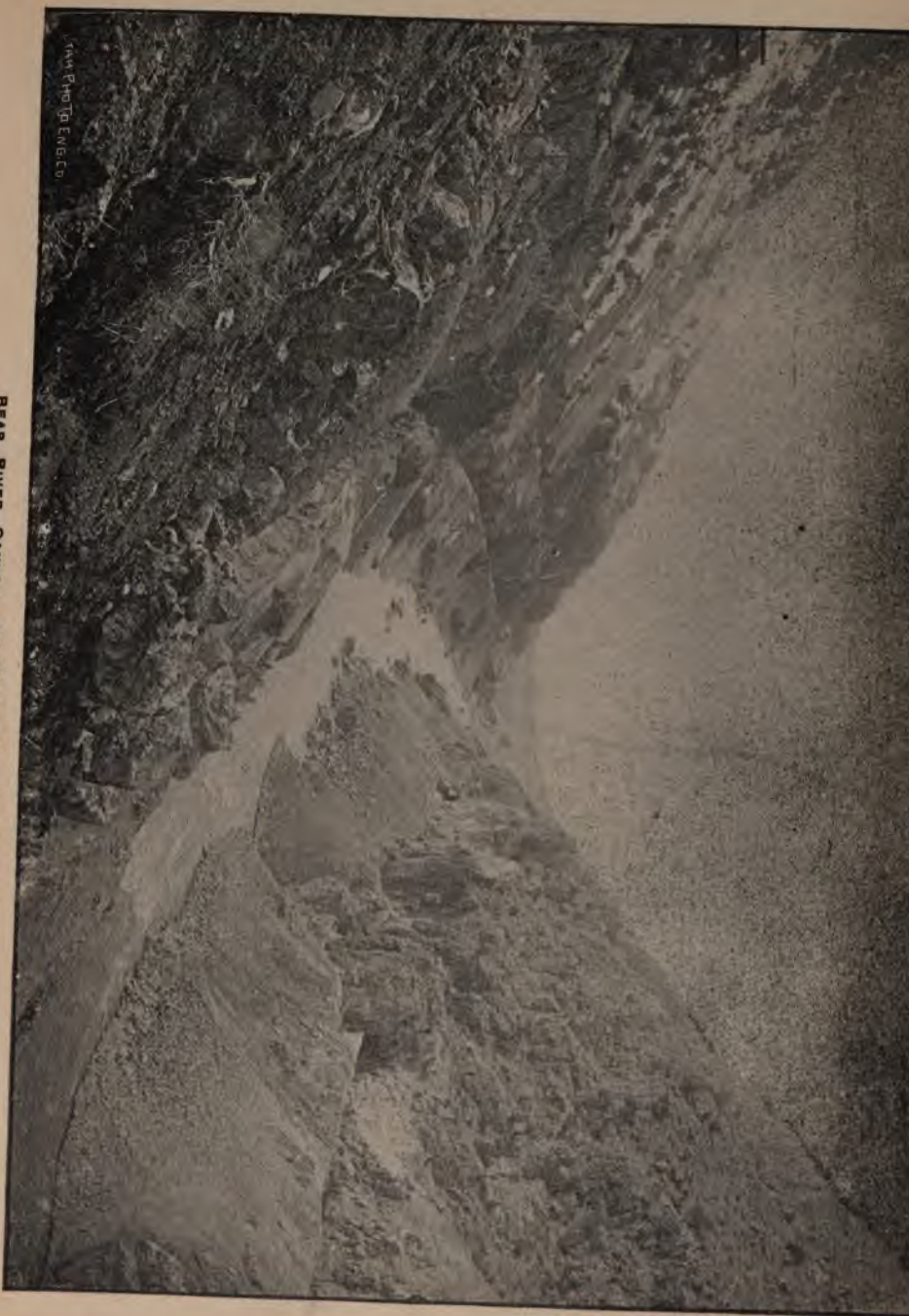
interested, furnishing their own labor, has thus far with us been attended with the best results.

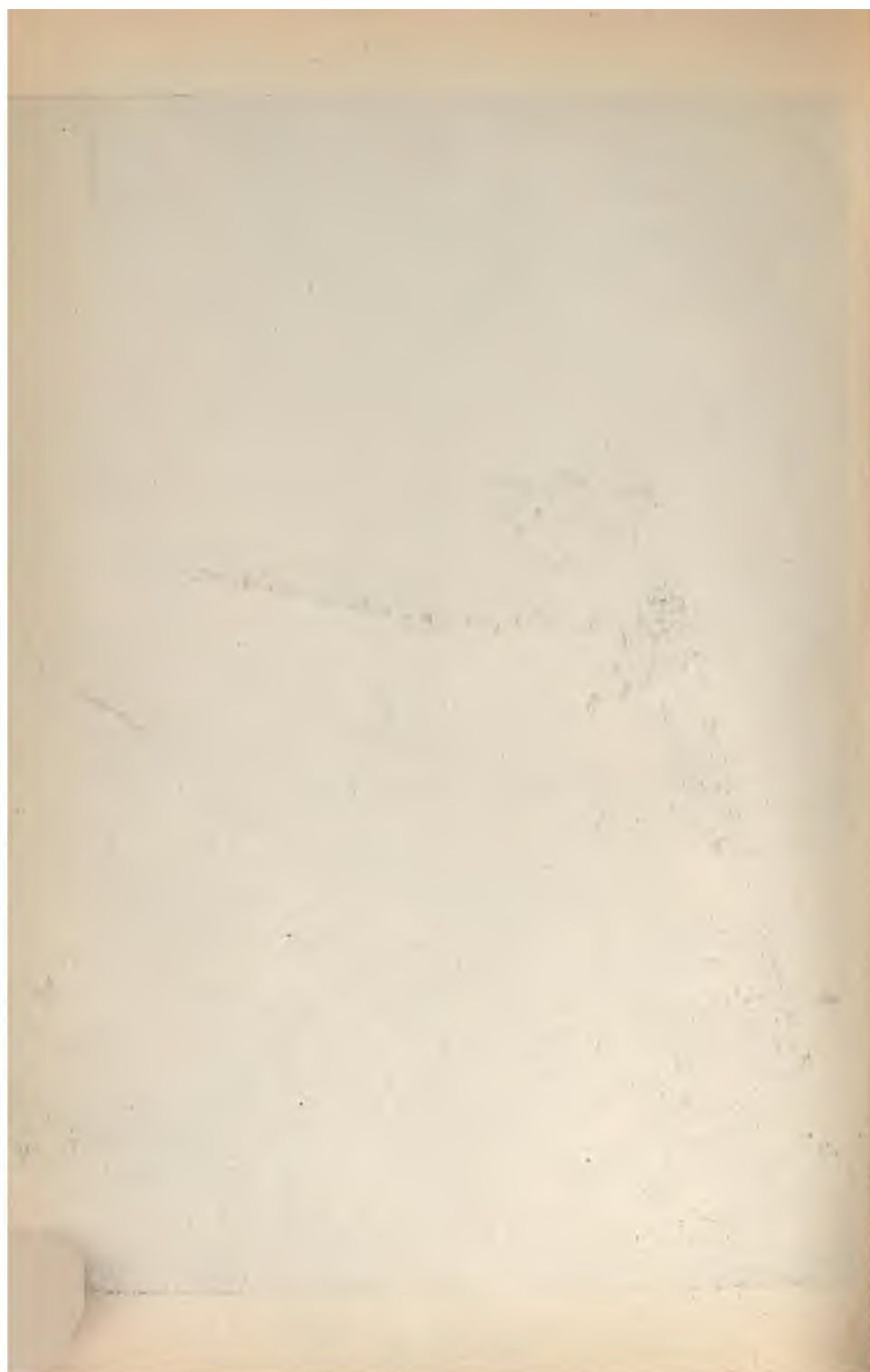
Ladies and gentlemen of this Irrigation Congress, I thank you for the honor you have done Utah in selecting me as the temporary chairman of this Congress.



144 PHOTO ENG. CO.

BEAR RIVER CANYON, ON UNION PACIFIC RAILWAY.





IRRIGATED UTAH AND HER NEEDS.

A Paper Submitted to the Irrigation Congress at Denver, September 1894, by Professor Fortier of the Utah Agricultural College.

EXISTING CONDITIONS.

On the 24th of July of each year we celebrate in Utah "Pioneer Day." We deem it a pleasure, as well as a duty, to perpetuate the day on which the first attempt was made to reclaim by cultivation and irrigation the western desert. From 1847 to the present our courageous pioneers and their descendants have never lost faith in the unlimited possibilities of the union of the soil and water of this western country.

While our sister to the west has been occupied in drilling and blasting for the gold and silver which are stored up in her mountains, the people of Utah have been diligently cultivating the soil. As a result we have our ten thousand pleasant country homes, surrounded by well tilled fields and filled with a happy, prosperous and contented people. But where, we ask, are the \$600,000,000 the products of the mines of Nevada? I say contented, because, notwithstanding the wave of depression which has swept over the Union, the Utah farmer, with a wheat bin piled high in the granary, Jerseys grazing in the lucerne patch, vegetables and fruit in abundance in the garden, owning his farm, and a share in the creek which flows from the adjacent mountain, this man, we claim, can well afford to be contented. While this great wave of depression has wrecked many a miner, mechanic and merchant, it has

but shown the Utah irrigator upon what stable foundations he has builded.

In our irrigation development we have followed customs, rather than any code of laws, and, although burdened with much that retards our progress, it is not without its advantages. *The occupied lands are in small holdings.* The desire of most men to possess large areas of land was controlled by ecclesiastical counsel and authority. In the fifties and sixties an old bachelor received only ten acres, a married man of small family twenty or thirty acres, while a man with four or five grown-up sons received forty or sixty acres. Hence we find that the average size of the cultivated farms in Utah to-day is less than thirty acres.

Another prominent feature of our system consists in the fact that the owners of the cultivated lands are also the owners of the available waters. We fear monopolies in water as we do rattlesnakes. As a consequence there are only one or two corporations in the whole Territory which conveys and rents water.

When an undertaking was too great for an individual to complete, an association was formed to do the work, and the existence of hundreds of small creeks from which water could be easily and cheaply diverted, made the effort of such associations eminently successful. Had the topography of the country been different, requiring large high-line canals twenty and thirty miles long, it is doubtful if the same methods would have proved practicable. As it is we rejoice in the fact that each farmer owns, and to a large extent controls his water right. *We believe that generations yet unborn will thank the first settlers of Utah for this priceless heritdge.*

There are, however; thorns among the roses, and we find that the co-operative efforts of the people were imperfectly directed and applied. The large number of badly constructed ditches, and the consequent waste of water, bear testimony to the truth of this statement.

In the matter of water rights the complications are increasing so rapidly that no one knows just where to begin to unravel the tangle. Incredulous as it may appear to our Colorado friends, we on this side of the ridge have actually tried to apportion

water in accordance with the Golden Rule. We temper with mercy the apparent harshness of the law of prior appropriation. "We built our ditches in the fifties," say the older settlers "while you did not complete yours till the sixties, but we are willing to stand on the same footing with you as regards priority of rights."

To define legally all claims to water at small cost to the owners, to apportion justly the water so defined, and to conserve the water supply, are the great questions which now confront us.

STORAGE RESERVOIRS.

As regards the conservation of the water supply we are entering upon a period of reservoir building. We think no State or Territory in the west has the natural facilities for the storage of water which Utah possesses. A mountain valley traversed by a creek or river and terminating in the almost vertical walls of a rugged canyon, is the rule rather than the exception throughout the general configuration. Several important sites have already been surveyed and their construction assured. Less than a month ago the writer made a survey of one whose height would be 120 feet, capacity 3,000,000,000 U. S. gallons, and total cost only \$65,000, or at the rate of \$12 per acre for the land watered.

The existing irrigation reservoirs, and those that will be built in the future, may be classified as follows:

1. The utilization of natural lakes.
2. The impounding of the waters from mountain streams in mountain valleys by means of high masonry walls built across narrow gorges.
3. The building of low earthen embankments near the foothills in order that the seepage and discharge from the water thus stored may irrigate the adjacent lands.
4. The construction by individual farmers of small distributing reservoirs to retain the flow of an irrigating stream over night, and thus dispense with the necessity of night irrigation, and to store enough water to irrigate particular crops between the times allotted by the canal companies for such waterings.

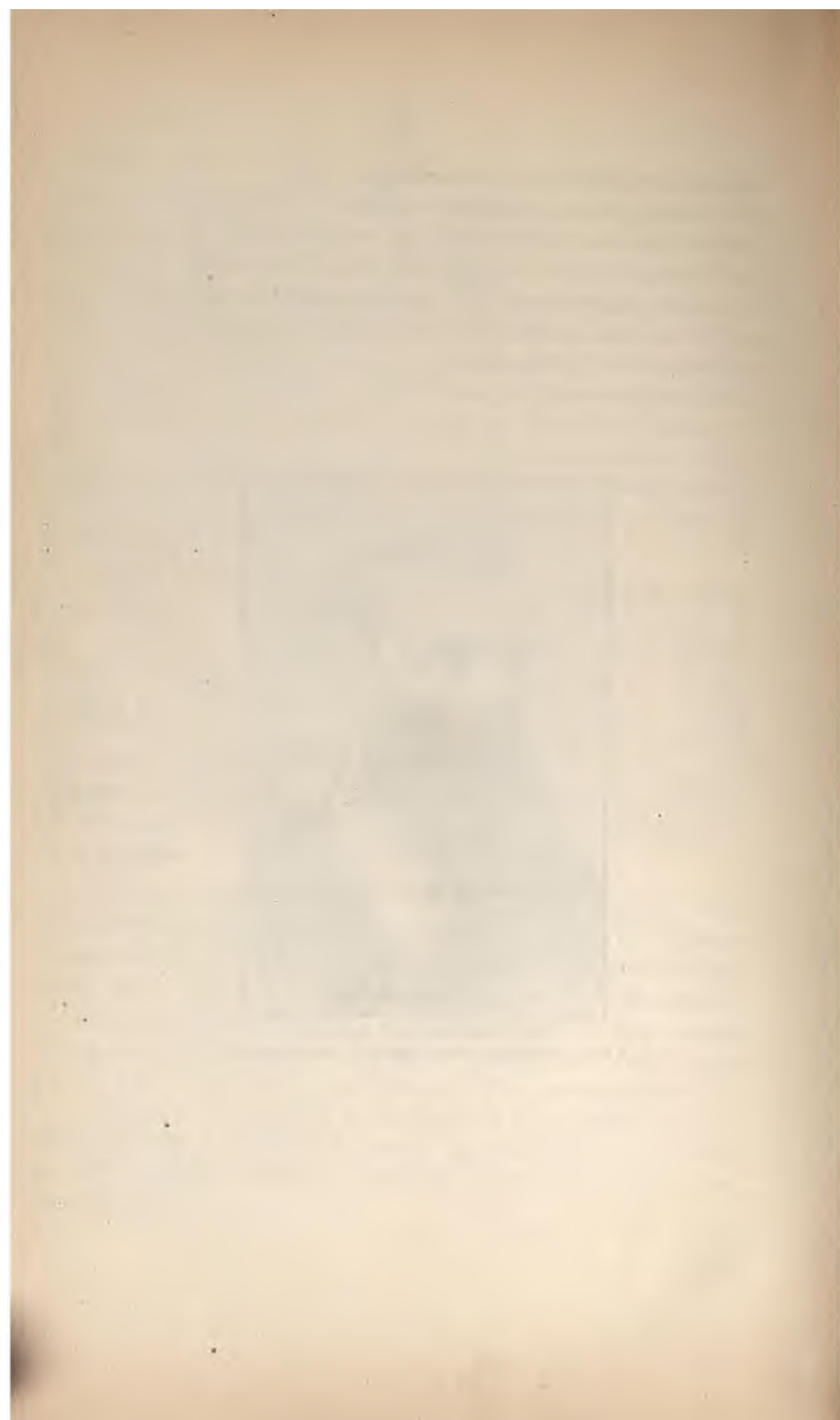
The writer has also suggested to communities favorably located another method of storing irrigating waters, namely, by forming ice of the waters on the higher table lands and valleys during the winter months and allowing it to melt by degrees during the following irrigating period. We have a large number of valleys and depressions, from 8,000 to 11,000 feet high, on which water could be cheaply piped or flumed, and where the temperature during the winter months ranges from 10 to 40 degrees Fahr. The only cost would consist in conveying the water through a flume or pipe, and in the labor of a man to distribute it in thin sheets over the side. The one question yet to be solved to insure its success is the time required to melt ice so formed. A trial on a small scale is necessary to determine this fact.

Many of our irrigators do not like to put money into reservoir schemes on account of the risk incurred in not being able to divert from the natural channel the water which has been allowed to flow into it from the reservoir higher up the stream. We are much in need of practical legislation to cover this point. To the hydraulic engineer the settlement of this question seems a simple one, merely requiring proper measuring devices in both the stream and canal at the points of inflow and diversion. The apportioning of the stored water could best be done under the direction of a State engineer.

In this connection Utah needs to protect her citizens by carefully prepared enactments against Johnstown disasters. There is no law on dam and reservoir supervision in any of the western states worth imitating. We must look to the recent enactments of Rhode Island and Connecticut for the best laws on this subject. The plans and specifications of all new structure should be approved by a competent commission, and the construction of all new dams, and the stability of all existing ones, should be made more secure by a periodical inspection by members of this board, in which sufficient authority should be vested to order the necessary repairs.



WM. H. ROWE, PRES. AND MGR.
Bear River Irrigation & Ogden Water Works Co.



THE ADJUDICATION OF WATER RIGHTS.

The number of irrigators in Utah possessing an undisputed legal claim to water may be counted by the dozens, while the claims remaining unsettled run up into the thousands.

There was a law on our statutes giving the selectmen of each county the power to decide disputes, but this law has become inoperative, and for many years past the only practical means of settling disputed title to water right has been through the district courts. The large majority of the farmers of this Territory are opposed to this means of acquiring titles to water rights for the following reasons:

First, it is too costly. To be obliged to set in motion all the machinery of the district courts in order to determine how much water flows in a particular stream, how much land it irrigates, and the legal owners of that water, is much worse than being obliged to hoist a ten-ton derrick in order to raise a sack of potatoes.

A recent irrigation case cost the litigants \$13,000, and all parties to the suit are agreed that it is not settled properly, and will in the course of time have to be fought over again. If the money spent in litigation were devoted to the building of reservoirs the happiness and prosperity of our commonwealth would be much increased. The present system is costly, owing to the large fees to be paid to lawyers, the expenses incident upon all court proceedings, and the large amount of time and money expended in bringing farmers sometimes long distances to await their turn to testify.

Second, it requires too much time. With our crowded dockets it would require about a hundred years to adjudicate all the claims to water rights. A suit that is begun in 1894 will have a referee appointed in 1895, testimony taken in 1896, and a decree issued in 1897. Although this last is a little uncertain.

Third, the decrees are unsatisfactory. A perusal of the testimony in the water cases of the west would reveal the fact that men will exaggerate, even under oath, and the present system in which attorneys, instead of a referee or judge, question the witness, seems to encourage this evil. It is a fact too that the decrees are

based almost wholly on such testimony. Far too little importance is placed upon the collection of physical data by disinterested parties. Yet the most essential portion of the evidence upon which to base a decree consists in the volume of water diverted and the use which it subserves. It is true that parties to a suit call in surveyors, and measure the water, but the surveyor may know as little about measuring water as our president knows of the planet Mars, and his employer may use every device known to man to make a good showing for his side of the case. The other party or parties to the suit may do likewise, and so the testimony of not only the farmers, but of surveyors and engineers differ so widely as to be not only valueless but misleading.

During the past few years my duties have led me to measure a large number of irrigating ditches and canals in Utah, and of the few for which decrees have been granted by the district courts, some carry as their maximum discharge less than one-half the volume which the courts have awarded them.

By a decree rendered in Wyoming by this court a ditch watering nine acres of land was given a flow of six second-feet, one watering 200 acres, twenty second-feet, while a third watered 2,000 acres received only five second-feet.

The maximum carrying capacities of sixty-five ditches in district No. 23 in Colorado represented a combined flow of less than 700 second-feet, yet the courts had decreed to those sixty-five ditches a total volume of over 2,000 second-feet.

DETERMINING THE VOLUME OF WATER DIVERTED AND THE USE WHICH IT SUBSERVES.

In all of the foregoing there is no reflection upon the judiciary of this land. We simply assert and maintain that our courts as they now exist are not well fitted to decide water cases. They should be reserved as courts of appeal.

In accordance with our law of prior appropriation and supreme court decisions but three things are required to establish a claim to water for irrigation, namely, the date of appropriation, the amounts diverted at different periods, and the area of land

irrigated. Now, if this be true, it is evident that the most essential part of the facts to be determined must come through the hydraulic engineer and land surveyor. That no partiality be shown such men should be in the employ of the state. When all of the irrigated lands of each individual owner on a particular watershed are accurately represented on a map sufficiently large to be intelligible, and when the courses and varying volumes of all the natural streams and canals are represented thereon, it is a comparatively simple matter to call in sufficient testimony to determine the date of appropriation, when first used, its amount, and the changes that have been subsequently made.

Several years ago the Colorado Legislature passed a law requiring owners "to construct and maintain a measuring wier or other device" near the headgate of each ditch. Wyoming has subsequently adopted the same provision. At the last session of the Utah Legislature we tried to introduce this much and a good deal more, but failed in all. There is a crying need with us to-day for accurate statistics in regard to the volumes of water carried by the various creeks, ditches and canals. The volumes vary so much that one measurement during the summer season would prove of little benefit. So we not only asked that measuring devices be erected and maintained, but that each private owner or company should, through their watermasters, observe, record, and transmit weekly a statement giving the exact guage reading of the water in each measuring box. The central office was charged with the rating of each measuring box and the calculation of all discharges. Had this been done we would have had now about 50,000 water measurements as the result of one season's operation.

A CHEAP AND EFFICIENT WATER COURT.

When all of the facts pertaining to both the lands and waters of a certain watershed are collected, mapped and tabulated, we should, I think; seek a cheaper court in which to take testimony and render decisions than our district court has proved to be. Better to hold court under a tent in some wheat field adjacent to

the water rights to be settled than to bring whole communities to distant cities to await their turn to testify.

For six hundred years the Valencian irrigators of Spain have settled their water questions with little or no expense through the peasant courts which held weekly meetings in the cathedral squares. Wyoming, in creating her Board of Control, but imitated the wise legislature of the ancient Moors, who introduced this kind of water court into Spain.

In so far as we in Utah understand our wants it is something like this that we need. We would go a step farther than the French or Spaniards, and instead of appointing a water court for each community we would appoint a general one for the whole state. Wyoming has perhaps gone to the other extreme in the selection of the five members constituting her Board of Control, in that the profession of law is not represented. We think this is a mistake. The duties to be performed by such a board are varied and require a diversity of talent and technical knowledge not to be found among the members of any one profession.

The principal duties of the Board for the first five years would consist in examining, surveying and mapping the lands actually irrigated, and the areas that might be reclaimed, and in examining, measuring and apportioning the water supply. This work to be well done requires the services of one well posted in both the theory and practice of hydraulic engineering. Besides these general subjects there are a number of minor ones equally important, as the storage and conservation of water, providing for proper drainage, a determination of rainfall, snowfall, absorption, seepage, underflow and the like, all of which require a knowledge of the science of hydraulics.

Again, in the adjudication of water rights, and in the ordinary transactions of the Board, questions of law would continually arise which could be properly settled only by one learned in the law.

The Board would also be charged with the supervision, control and diversion of all the waters of the state. Officers competent to perform this task need to possess above all things a thorough knowledge of the practical side of irrigation, and of the needs and

customs of the people. They should also be men of executive ability, with a sufficient knowledge of water to be able to properly control and divide.

This, then, in outline, is the kind of a board or commission which we desire to see established in Utah. It matters little what we call it; everything depends upon the men composing it.

The State of Wyoming is to be congratulated in being the first American commonwealth to introduce this system which antedates in antiquity to the Justinian code. That this new court is efficient is evidenced by the fact that in less than two years after its establishment 947 claims to water rights were adjudicated, with only six appeals, and at little cost to the owner.

As a further evidence of the confidence which the people of Wyoming have in the decisions of this particular court, the superintendent of division No. 1, in the report of 1892, gravely inquires if a way could not be devised to annul the decisions of the district courts and have them re-adjudicated by the Board of Control. "The existing decrees," he says, "appear to have no particular basis for the amounts decreed, except that each claimant was allowed all that he claimed, regardless of what effect it might have on other rights."

LESSENING THE NUMBER OF SUPERVISING OFFICERS.

Colorado has sixty-eight irrigation districts, supposed to be controlled by as many water commissioners, six grand divisions over each of which a superintendent of irrigation is placed. All these officers receive five dollars per day while on duty. Wyoming has followed suit with something like forty districts and four divisions, and pays each officer ten dollars for every day he works.

In Utah we have been practicing irrigation for nearly fifty years, with fairly good success, as most of you know, with only our watermasters and occasionally the county selectmen to aid us. Now, we have been studying this matter and have concluded that we shall not be burdened with a host of district water commissioners on pay, if we can get along well without them. From the

feeling at present existing among us we shall, in all probability, allow each district, corporation, or community to appoint its own water divider, just as we have done in years past. If we do not succeed it would be an easy matter to extend the system to the smaller subdivision.

Our conditions differ materially from those of the adjacent States, in that we have a smaller number of large canals, and a larger number of small creeks. In one small county having a population of a trifle over two thousand there are twenty private or individual ditches, and twenty-eight corporate and company ditches, taking water from ten creeks and one river, and irrigating in all about 6,000 acres. Now, a wise provision in our laws gives us the privilege of measuring water "by the fractional parts of the whole source of supply." In the county in question, the most of the ditches have their sources in a mountain creek, and if A owns one-fourth, B one-third, and C the balance, the apportionment, after proper measuring wiers have been constructed and the rights of each claimant legally defined, is easily done. For these reasons and others that might be named we believe that Utah can, for a time at least, dispense with irrigation districts similar to those in Colorado and Wyoming.

LARGE STATE DIVISIONS A NECESSITY.

If, however, we decide not to create these smaller divisions we must make all the more of the larger divisions and impose more varied duties upon the commissioners or superintendents who are elected or appointed over each. As members of the state Board, composed say of five superintendents of divisions, a state engineer, and a secretary well versed in irrigation law, their duties would be not only to assist the Board in the settling of water rights, but each superintendent, aided by the state engineer, would have to regulate the appropriation, diversion and distribution of all the waters in his division.

By maintaining an efficient engineer's office, and by the introduction of a good system of keeping a continuous record of the

flow of water in all the water courses, and of having the measurements ready at the office of the secretary of the Board to be forwarded by wire or letter upon a receipt of the order, it is believed that five men will regulate the waters of a state better than fifty water commissioners under the old-fashioned haphazard system.





JUDGE L. W. SHURTLIFF,
Chairman Utah Irrigation Commission.



C. L. STEVENSON,
Hydraulic Engineer, Secretary.



PROFITS FROM IRRIGATION IN UTAH.

An Address to the Kansas State Irrigation Convention held at Hutchinson, November 23-24, 1894, by C. L. Stevenson, Irrigation Engineer of Salt Lake City.

The theme assigned me by which to show what are and what may be the profits due to irrigation in the Territory of Utah, is one so replete with facts of demonstration that it is difficult to make selections. There is, however, a quotation from English literature, which trite as it may be, enables me to start with it as an appropriate text.

"And he gave as his opinion, that whoever could make two ears of corn, or two blades of grass to grow upon a spot of ground where only one grew before, would deserve better of mankind and do more essential service to his country than the whole race of politicians put together."*

When the great satirist, Dean Swift, wrote these few words, he little thought how completely they defined the value of man's efforts in irrigation, and the Brobdingnagian philosopher when he gave utterance to them, expressed in a nut shell the reason why the profits from agriculture in many instances have been phenomenal in Utah.

And yet these results are not due to the reason that the Utah agriculturalist is a good farmer, for as a matter of fact he is, on the average, just the opposite, and yet, with all his careless, shiftless ways, his returns from a given quantity of irrigated land are double those of his hard-working, care-taking prototype of the northern and eastern states.

*Tartar, Chapter VII, Voyage to Brobdingnag.—Swift.

When the farmer becomes his own rain maker he can, of course, with reasonable skill, always insure a crop, but as there are farmers and farmers, so also are there irrigators and irrigationists, and it is the latter, who, all other things being equal, secures the best and most profitable results. While the climate and soil of Utah are among the best, it is nevertheless the fact that the application of moisture at the proper period is the main factor in the securing of big crops of the best quality, hence best prices for all raised. While the *average* of crops grown by irrigation in Utah is perhaps but little more than that on like irrigated lands in the adjacent territories, there are so many instances of what can and has been done to exceed the average, that we may at once go into statistics to show profits had from given areas.

In 1889 the American Agriculturalist offered a prize of \$500 to the farmer raising the largest crop of wheat to the acre in any part of the United States. This prize was secured by William Gibby of Salt Lake City, who raised 4,806 pounds of clean wheat, or 80.1 bushels from an accurately surveyed acre of ground. The crop came up in the middle of February, 1889, and received no attention until April 10th, when it was rolled once. No other care was given it until harvest time and the prize acre received no different treatment than the general wheat crop on the farm, the entire yield of which averaged 70 bushels to the acre. Five pecks of seed were sown to the acre. In this connection it may be well to cite that there are numerous small farms throughout the Territory where the wheat crop averages 60 bushels per acre year after year.

In 1890 the average crop of wheat in Utah was 23.2 bushels per acre, and in 1891 the Agricultural College reports it as 29 bushels. The price in Utah averages rarely less than 60 cents per bushel, with a constant home demand; exports, except for the very superior flour from Utah grain, being only nominal.

During the season of 1890-1891, the statistical returns made to the first National Irrigation Congress held at Salt Lake City, showed that crops were raised by irrigation on 396,000 acres, say about three-fourths of one per cent. About 85 per cent. of the

cultivated areas required irrigation, the remaining 15 per cent. being "dry farmed."

The average size of the portions of farms under cultivation was 40 acres. The average first cost of the water right is \$10.55 per acre, and the average first cost of preparing the soil for cultivation, including the purchase price of land is \$16.10 per acre. The average present value of the irrigated land of the Territory, including improvements, etc., is reported at \$84.25 per acre, showing an apparent profit, less cost of improvements, of \$57.60 per acre.

The average of the estimated value placed by the farmer upon this water right is \$26.84; this is the price which the water rights, wherever transferable without the land, have usually brought or would probably bring in the various localities, the value of these rights being dependent largely upon the probabilities of the owner receiving the amount of water claimed.

A TYPICAL CASE.

The following statement, based on actual experience, and made by one of the most intelligent farmers in Utah, shows the prime cost of settlement; what he has done and what may be done with a typical farm of 40 acres, well irrigated land and properly handled:

EXPENDITURE.

First cost 40 acres of land and water right, \$40 per acre,	\$1,600.00
One mile of fence, (4 wire)	140.00
Dwelling house, complete,	600.00
Stable, barn and sheds,	260.00
Clearing, plowing and harrowing 40 acres,	150.00
100 shade trees,	15.00
200 fruit trees,	30.00
10 acres planted to alfalfa and seed,	20.00
20 acres wheat and seed,	30.00
4 acres of potatoes, seed and planting,	20.00
5 acres of oats,	10.00
Water rental,	80.00
Total,	\$2,955.00

FIRST YEAR'S RETURNS, HARVESTED.

800 bushels of wheat, 60 cents per bushel,	\$ 480.00
1,200 bushels of potatoes, 50 cents per bushel,	600.00
250 bushels of oats, \$1.00 per bushel,	250.00
10 acres of alfalfa and seed ($\frac{1}{3}$ return)	150.00
Total,	\$1,480.00

The above shows a net earning of 50 per cent., or one-half the total amount invested, for the first year's work.

The two blades of increase here given are sufficiently assuring as to good farming results, but the following verified reports recently made to the Salt Lake Chamber of Commerce show that even the two blades may be multiplied by those skilled in irrigation. I cite two counties as taken from official sources, they being the latest from which returns are available.

UTAH COUNTY—1893.

	Acres Cultivated.	Average yield per acre.	Highest yield per acre.	Average Price.
Wheat	11,000	30 bu.	60 bu.	\$.70 per bu.
Barley	8,125	32 "	76 "	.90 per cwt.
Oats	6,240	35 "	90 "	1.00 "
Rye	5,460	25 "	50 "	1.00 "
Sugar	2,200	13 tons.	35 tons	5.00 per ton.
Orchard and vineyard	3,640			
Potatoes	3,000	300 bu.	840 bu.	.30 per bu.
Sorghum	650			
Buckwheat	600			
Flax	230			
Garden	2,100			
Alfalfa	23,790	4 tons.	10 tons.	5.00 per ton.
Tame and wild grasses.	16,500	2 "	3½ "	7.00 "
Forest and Park	3,000			

Nearly all of the products are consumed within the Territory with the exception of barley, rye, potatoes and alfalfa. These find ready sale in the Eastern market, a higher price being paid for the barley and rye than for the Eastern prairie product.

With more intensive farming let us record Davis County, in the vicinity of the town of Bountiful, but which more properly

comes under the head of market gardening. The following shows the yield per acre and average price:

Lettuce	14,000	@ \$.02 per head,	\$ 280.00
Early Cabbage	12,000	" .05 " "	600.00
Early Cauliflower	7,260	" .10 " "	726.00
Onions	600 bu.,	" .75 " bu.,	450.00
Parsnips	1,800 "	" .25 " "	450.00
Carrots	1,800 "	" .20 " "	360.00
Tomatoes	2,250 "	" .40 " "	900.00
Potatoes	350 "	" .75 " "	262.50
Large Peas	306 "	" 1.00 " "	306.00
Small Peas	200 "	" 1.25 " "	250.00
Green Beans	400 "	" .90 " "	360.00
Cucumbers	250 "	" .50 " "	125.00
Asparagus	5,500 lbs.,	" .08 " lb.,	440.00
Rhubarb	7,000 "	" .01½ " "	105.00
Corn	2,420 doz.,	" .10 " doz.,	242.00
Celery	30,000	" .03 " stalk,	90.00
Cantelope	1,814 doz.,	" .60 " doz.,	1,088.40
Watermelons	862 "	" .40 " "	344.80

Yield per acre and highest market price in the early part of the season:

Lettuce	14,000 heads	@ \$.02½	\$ 310.00
Cabbage	12,000 "	" .10	120.00
Cauliflower	7,260 "	" .15	1,089.00
Onions	600 bu.,	" 1.50	900.00
Parsnips	1,800 "	" .40	720.00
Carrots	1,800 "	" .25	450.00
Asparagus	5,500 lbs.,	" .12½	687.50
Rhubarb	7,000 "	" .05	350.00
Corn	2,420 doz.,	" .20	484.00
Tomatoes	2,250 bu.,	" 2.00	4,500.00
Celery	30,000 heads,	" .06	1,800.00
Cantelope	1,814 doz.,	" 2.00	3,628.00
Watermelons	862 "	" 1.50	1,298.00
Large Peas	300 bu.,	" 1.25	375.00
Small Peas	200 "	" 2.00	400.00
Green Beans	300 "	" 3.00	900.00
Cucumbers	350 "	" 2.00	700.00
Potatoes	350 "	" 2.00	700.00

The above figures are compiled and attested by Ephriam Briggs and Brigham Holbrook of Bountiful, Davis County, Utah.

A man having a wife and five children reports being able to make a comfortable living from an acre and a quarter of land at Bountiful.

Joseph T. Mabey gives the following statement of products per acre:

Carrots	1,500 bu , @ \$.22	\$ 330.00
Table Beets	1,200 " " .25	300.00
Onions	850 " " .75	637.50
Potatoes	600 " " .35	210.00
Downing Gooseberries	800 " " 2.50	2,000.00

Richard E. Egan has produced strawberries that yielded him \$600 to the acre. A. L. Buckland, Bountiful, has realized \$1,500 per acre, one year, from his strawberry patch.

E. P. Ellison at Layton, in the northern part of the county, gives the following averages:

Wheat, dry farms, 22½ bu. per acre, average price, 65c. per bu.

Wheat, irrigated, 50 bu. per acre.

Barley, dry farms, 25 to 30 bu. per acre, average price, 65c. per 100 lbs.

Barley, irrigated, 60 to 70 bu. per acre.

Oats, irrigated, 60 to 70 bu. per acre.

Lucern, best crop, 7 tons per acre, \$4.50 per ton.

These figures represent averages, but authentic reports show 110 bushels of oats and 100 bushels of barley per acre.

The practice of irrigation as given by the farmers of Davis County, or by President Woodruff on his twenty-acre patch in Salt Lake Valley, show that as a rule, the average Utah farmer firstly uses too much water, secondly, he does not vary properly the quantity of water to suit the different character of his crops, and thirdly, he rarely keeps up that degree of surface tilth that, while admitting the atmosphere, best retains the moisture by lessening the evaporation. All these things he is gradually learning, and a few years hence, the same amount of water will fully irrigate double the amount of land.

As a topic germane to the raising of crops by irrigation, the amount of water applied to the soil to mature an average crop in

Utah, will, I believe, be of general interest; this amount being usually known under the term of

DUTY OF WATER.

The "duty of water" signifies the area of land upon which a definite volume of water, applied during a given period, will successfully raise crops. Thus the average duty in Utah of one cubic foot per second during a period of one hundred days—one hundred acres.

The following table, published by Professor Fortier, of the Utah Experimental Station, shows the various depths of water applied to the land in producing the crops mentioned; the duty being calculated on the general basis of one hundred days. The crops were raised in Weber and Box Elder Counties:

No. of Test.	Kind of Crop.	Depth of Water.		Duty of Water in Acres per Sec.-ft.	Produce per Acre.
		Inch.	Feet.		
1	Strawberries.....	5¼	0.45	566	.....
2	Cauliflower.....	8¼	0.69	291	7½ tons.
3	Tomatoes.....	24¾	2.07	97	10 "
4	Mixed Crop.....	23	1.92	103	.....
5	Barley.....	7¼	0.60	330	55½ bushels.
6	Corn.....	3¾	0.31	660	30 "
7	Potatoes.....	16¾	1.39	143	423 "
8	Onions.....	35½	2.96	67	19½ tons.
9	Strawberries.....	27½	2.30	93	300 cases
10	Peach Orchard.....	12	2.00	213	No record.
Mean....	.....	16 4-10	1.37	256	.....

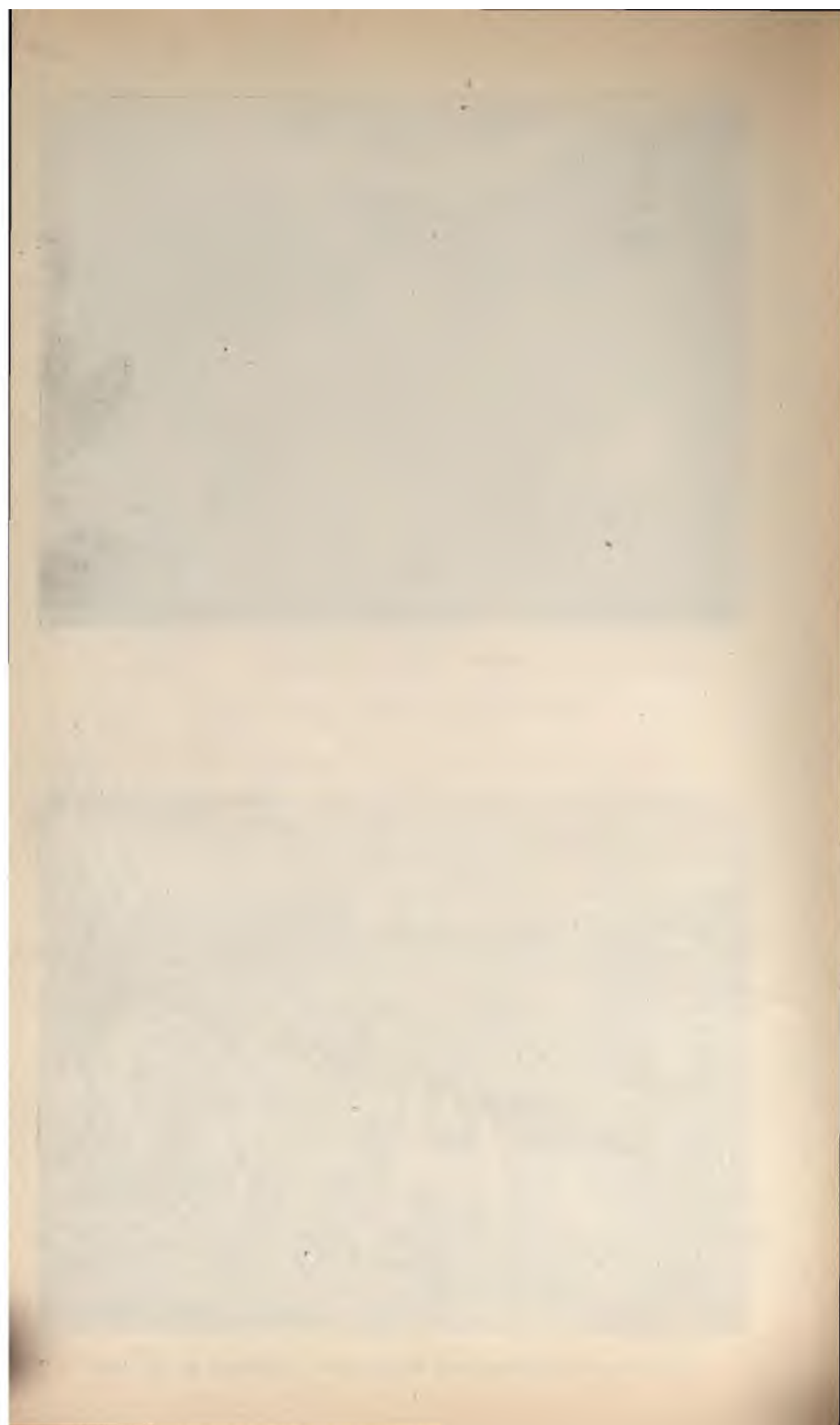
In Utah generally, the units of measure are the cubic foot, the gallon of the miner's inch. To show the relation which the different units and measure bear to each other, the following irrigation flow tables are for the first time herewith published, as it is believed they will be of value to all irrigationists:



BARLEY FIELD OGDEN VALLEY.



IRRIGATED CABBAGE FIELD NEAR OGDEN, UTAH. 8,000 HEADS TO THE ACRE.



ADDRESS BY THOMAS R. CUTLER,

*Of the Utah Sugar Company, of Lehi, Utah, to the Third National
Irrigation Congress.*

SEPTEMBER, 1894.

Mr. Chairman, Ladies and Gentlemen :

The fact that the United States sends abroad for sugar, annually, for home consumption, more than one hundred millions of dollars, has come to attract the attention of the American people, which consumption, amounting to an average of seventy-two pounds per head of the seventy millions of people, computed, means more than five billion pounds consumed in this country each year, which is constantly increasing. In fact, we are greater consumers than any other nation on the face of the globe. Of this enormous amount we are producing but about one-tenth, in cane and beet sugars, and this in a country that nature has particularly endowed with all the elements necessary for the complete success of the industry, under wise and beneficial legislation.

While this congress is dealing with the question of irrigation with the view of opening up the arid lands of the sections of this country, we are even now confronted with the question of obtaining a profitable market for our surplus products, as since many of our industries have been stricken down, we are obliged to carry such products enormous distances to find a market, the freights on which cut down the prices so that the farmer cannot live and keep out of debt without the most rigid economy. We all realize the necessity of establishing manufactures to work up our raw materials and give employment to thousands of idle labor, and endeavor to find a market for our products at home. There is no single industry that offers itself to our notice more prominently for

the arid regions than that of beet sugar; and with this view I have endeavored to give a brief statement of what Utah is accomplishing in this regard.

When about four years ago a few Utah men formed a company and proceeded to build a factory to manufacture sugar from irrigated beets, the idea prevailed that artificial irrigation would never produce sugar, and we were assailed on all sides with prophecies that we would fail in our purpose; but the company undauntedly proceeded with the work, and built and equipped a factory having a capacity to use three hundred and fifty tons of beets per day of twenty-four hours during the sugar season, at a cost of over half a million dollars; and also bought land that cost us more than one hundred thousand dollars, and all the necessary agricultural implements of which many had never been seen in this country, at a very heavy outlay; fully realizing that it would be necessary to educate the farmer by first making a success of the raising of the beets ourselves, as we were perfectly aware that it would require the most intensive cultivation, and unless we set the example he would be very apt to become discouraged.

We have been in operation three seasons, and have made each season the following number of pounds of granulated sugar:

The season of 1891, one million one hundred thousand pounds.

" " " 1892, one million five hundred thousand pounds.

" " " 1893, four million two hundred thousand pounds;

and this present season, which will commence in a few days, we shall work thirty thousand tons of beets and probably make therefrom, five million pounds of sugar.

Cutting off the sending abroad for this season alone of three hundred thousand dollars, Utah pays annually for sugar upwards of one million, and Colorado two millions of dollars.

The sugar beet must not be confounded with the ordinary garden or field beet. We import the seed direct from France and Germany where it is grown to a high state of perfection. And in fact, I know of one French gentleman who has devoted his whole life to the perfection of the beet seeds. The typical beet when ripe weighs about two pounds; is elongated in appearance, and its

nature causes it to go down in the soil in search of moisture, the head or crown, not being permitted to grow above the soil. It is a hardy plant, requiring less moisture than any other vegetable. We sow the seed in April and May, and harvest the beets in September and October. There is no difficulty in obtaining fifteen tons to the acre where the land is in good condition, and the necessary work put on the crop, and there is no crop that will insure as many dollars to the acre. Such crops will solve the problem of how to make small farms pay, therefore, making the irrigation system a more economical one, and quadrupling the ability of such water to support a dense population.

The cost of the entire production, including the seed and delivering to the factory, is about \$35.00 per acre, and as we have paid an average of \$5.00 per ton for beets, the farmer can make an excellent profit. Many of our farmers last year raised as high as twenty to twenty-five tons per acre; but there are always some who make partial failures, generally through their lack of system and perseverance, and their untidy methods of doing their work. But I contend, that when our education is further advanced, there will be no necessity for failures under the irrigation system. There are other beet factories where farmers have to depend more or less upon the rains in a dry season to bring up their seed, but in this case we always have that question at our command.

To work a crop of 30,000 tons of beets requires about 5,000 tons of coal, 2,000 tons of lime rock, 100,000 sugar bags, and large quantities of other supplies, many of which are of a local character. And I again repeat that there is no other industry that will employ such an equal amount of diversified labor and material as the beet sugar industry.

I am repeatedly asked if smaller factories cannot be operated, and, while I am aware of the enormous amount of money that is required to build and equip a factory, I must emphatically answer *no*. That no such factory with less than 1,000 tons of machinery can be operated with profit, as it would require every part of such machinery to be in active operation to produce even one pound of granulated sugar, together with every other elaborate

detail of laboratory or chemical work, and a fixed expense which cannot be obviated. It would be more profitable to work factories of a greater capacity than less, if all the surrounding conditions were favorable. It would take one thousand factories the size of ours to provide the United States with the sugar that it annually uses.

The crop does not impoverish the soil. The intensive cultivation required, together with such fertilization by plowing in the beet tops and other natural means within the reach of the farmer, improves the land; and wherever a factory has been established and is in successful operation, the lands have wonderfully increased in value. In France and Germany as much as \$40.00 per acre is annually expended in artificial fertilizers, every inch of soil being made to produce abundantly, and hundreds of thousands of the peasants make a fair living on farms of from three to six acres.

Our Utah farms are generally small and much of the labor on the beets is done with young boys, thus educating them to honorable and remunerative labor. The pulp, of which we get about 50 per cent. of the weight of beet, is very valuable food for cattle and hogs, and in foreign countries brings much higher price than it does with us, on account of the difference in the price of hay; but it makes excellent beef—tender and juicy, and is being appreciated more and more each year. We have also a low product of molasses which can be made into vinegar, and in other countries is used very much in the manufacture of alcohol; but as most of our soils contain alkalies, or mineral salts, in a greater quantity than is desirable, and as most of these salts are finally deposited in the low product of molasses, it will be several years before we can eliminate them in such a manner as will make such product profitable in this country. Our machinery is American make, and is perfect in every detail; there is no necessity to go abroad for sugar machinery. The whole question now is purely an agricultural one, and the Rocky Mountains enjoying so much sunshine, and with every resource to make this a prominent industry, it only remains for the people to set to work with a will.

It must be demonstrated by actual experiment in localities within reach of proposed plants, that they have the suitable soil, cheap labor, cheap coal, and suitable lime rock, with a pure water supply for manufacturing purposes of at least two million gallons each twenty-four hours. Nor must any one expect that they can jump into success at once; for in the language of Professor Wiley, of the Department of Agriculture at Washington, "There is no crop within the whole range of agriculture more difficult to produce than a crop of beets suitable for the manufacture of sugar." On the other hand I maintain there is no crop that will produce the same permanent results if raised by patience, perseverance and determination to succeed.





CELERY FIELD, OGDEN, WEBER COUNTY.





MY TWENTY-ACRE FARM.

WILFORD WOODRUFF, PRESIDENT OF MORMON CHURCH.

To the men who came into the valley of the Great Salt Lake in 1847, and during the years immediately following, irrigation was a new and untried resource. Whatever historians may say as to its successful practice in earlier times and in other lands, yet, moved by an impulse that may almost be regarded as inspiration, the very first of Utah's settlers seized upon it as the solution of the problem of life in what was most truly called a desert, and with scarcely more loss of time than was necessary for the transfer of teams from wagon to plow, the water of a mountain stream was brought out of its rocky channel on to the thirsty soil.

I had the honor to be one of the small number who pioneered the way from the Missouri River to the present site of Salt Lake City. In my wagon rode the bedridden leader of the company, Brigham Young, ill of mountain fever, when, on the 24th of July, 1847, we emerged from what is now called Emigration Canyon, and gazed upon the valley in which our chief city now stands. That very day potatoes were planted from seed brought more than a thousand miles in our wagons, and the sun-baked field was soaked with water turned from the canyon stream. Whatever we may have lacked in experience, we accordingly made up in zeal; and I think it can be said of all our settlements, that sightliness of location, advantages of surroundings, and even superiority of soil, have all been considered of minor, or at least secondary, importance to the prime object of getting water with sufficient ease and in sufficient quantity.

The record of the agriculturists of Utah, as far as the latter have conformed to the plans laid down by the original settlers, seems to me to possess three distinctive and derserving features: first, that small farms are the rule, and give the best results; second, that the land-owners themselves, either individually or in combination, can more profitably and economically lay out canals and acquire an adequate and perpetual water right than to lease or purchase such right from corporations or capitalists; third, that notwithstanding the dryness of our climate and soil, there is really a great deal less water needed than most farmers think, and consequently, many of us use an extravagant quantity, to our own injury.

My own experience has been asked for, and it will bear out all three of the foregoing propositions: The original idea was that each man's land, both in the city and for farming purposes, should be measured out to him, and he "should be industrious and take care of it." This was but another way of saying he should have no more than he could industriously cultivate and take good care of. So, while our city lots were generous in size—an acre and a quarter, the idea being that thereon might be grown both orchard and garden—our fields were small. An early farming plat was subdivided into five-acre tracts, and one was soon afterwards known as the ten-acre plat. In 1850, the third year after the arrival of the Pioneers, I purchased a piece of land of ten acres in what is now known as Farmer's Ward, south of and contiguous to Salt Lake City. In the near vicinity I had already acquired two five-acre lots. These I exchanged for ten acres adjoining the first-named tract. This gave me twenty acres in a single farm. With it I resolved to be content, and I immediately began its cultivation.

I joined my neighbors in placing a dam in a stream from the mountains (then called Mill Creek, now Canyon Creek), and in opening up an irrigating ditch of sufficient size to bring water to their land and mine. This water I have used, and this land I have cultivated, from that time to the present. The products of my farm have been wheat, oats, barley, corn and potatoes. I made

it an early rule to follow the practice of annual rotation of crops; for example: I would sow wheat and small grain to the ground that the year before had produced corn and potatoes; and, *vice versa*. I also set aside about two acres out of my twenty for an orchard, and planted trees of the apple, pear, peach, plum and cherry, besides small fruits, and all have done well. During recent years—for the introduction of the plant is of comparatively recent date in Utah—I have devoted five acres of my farm to lucern, which has yielded me three good crops each season.

From this twenty-acre farm has come the main support of my family during nearly forty-four years. Only once in that time have I had less than forty bushels of wheat to the acre. Four years ago I had sixty bushels, and two years ago, sixty-five bushels of good, clean wheat to the acre; and one season, from five acres of seven-headed wheat, I actually threshed three hundred and fifty bushels—seventy bushels to the acre—which, however, though fine looking grain, was not suitable for milling purposes for flour, as when ground it had almost the coarse appearance of corn meal. Some of my neighbors have with practically certain regularity raised from fifty to sixty-five bushels per acre; and one of them, Mr. William Gibby, took the prize of \$500.00 offered four or five years ago by the *American Agriculturist* for the largest yield of wheat per acre in the United States—between eighty-five and ninety bushels. I preferred the White Club variety and had the best results from it; Club and Taos have been the main kinds used in Utah, though at various times and to meet special conditions, other classes have been sown and have yielded well.

As to the amount of water needed, I give again my own experience: I irrigate my crops not more than twice in a season, and the wheat generally but once. As to fertilizers, I have used nothing but barn-yard manure.

In conclusion, I desire to say that I recognize the advantages of small farms well tilled, and their capacity for furnishing sustenance for the thrifty husbandman. I have found that with much less water than is generally used, the yield from the land would be equally good, if not better. And I have also found that the man-

ner of irrigation inaugurated by the Pioneers of Utah has served its purpose splendidly, has proved a great success, and with us has been no expense to the farmer, except the labor of his own hands. By this system Utah has won the agricultural prominence she now enjoys, and by the same system still more thoroughly carried out, I am sure she will not only maintain but vastly increase her prestige.





SUGAR BEET FIELD, UTAH COUNTY. 39 TONS TO ACRE.



WHEAT FIELD.



SOME GENERAL FACTS CONCERNING UTAH.

BY H. L. A. CULMER.

The agricultural possibilities of Utah, especially those in relation to the developments in irrigation, having been clearly set forth, it is proper to devote some space in these pages to other material resources of the Territory, so that it may be seen how varied and extensive are the operations of the people, and what opportunities exist for enterprise and investment. Outside of the climate and agriculture as resources of the Territory, there are mining, manufacturing, stockraising, and the commerce that depends upon all and whose interests are intermingled with all. Reference to the annexed diagram will make it easy to understand the relative situation of each county in the Territory without a map. At one time, they might consistently have been grouped into the Northern, Central and Southern Counties, because of their separate interests, but the developments and railway extensions of recent years have drawn them all together in one compact whole, so that the affairs of each county are becoming, year by year, more closely identified with those of all the others.



There is not a county in the Territory that is without important mining as well as agricultural interests; each has gold, silver, copper and lead mines, and nearly all have coal, iron and other valuable minerals within their lines; every one has its farms and ranges, and many have well-defined industrial possibilities. The residents of the whole Territory can see great cause for hope in the future developments, and, together, the counties constitute a union of related interests

more diversified than those of any other country of the same area that can be named.

COMMERCE—As a general proposition, other states maintain their activity in special lines; but in Utah the range of subjects which the man of trade is called upon to study is bewildering, and as varied as the numberless resources, mineral, agricultural and industrial, that occupy the attention of the people. The volume of trade fluctuates less in this community than in most others, principally because Utah has enjoyed a continued run of comparative prosperity for a great number of years, and this in turn is largely due to our system of almost universal irrigation. Crops never fail, but can be depended upon with almost absolute certainty. Then again, the variety of means by which the people of Utah are sustained, makes it next to impossible for all of our resources to be depressed at one time. If silver and lead happen to be low, copper, sulphur, asphaltum, grain and cattle may happen to be high, so that a drop in the metal market, which would paralyze a community depending alone upon mining, might scarcely be felt by the people of Utah, whose interests are distributed over such a large and varied field. In Ogden, Provo, Logan and Salt Lake City, a genuine jobbing trade is supported, all the leading lines being represented by exclusive houses. Their trade is not confined to this Territory, but extends for hundreds of miles into other districts. Many of the merchants are also traders, being engaged in gathering together products of the Territory for export to remote distances. Grain, seeds, hides, wool, live-stock, tallow, furs, skins, eggs, butter, poultry, green fruit and vegetables, dried fruit and such things, usually sent out in carload lots, return a considerable revenue to many of the towns and cities adjacent to the railways. Besides this, those engaged in developing the mineral and other resources of the Territory, ship a great many carloads of stone, marble, onyx, sulphur, asphaltum, plaster of Paris, fire brick, etc., both east and west. The shipment of ores and bullion, gold, silver and copper, is confined principally to the work of the banks and smelters, and this, more than all else, brings the ready money into the avenues of finance. In 1890 there were

1722 stores in Utah, having over \$20,000,000 invested. The annual sales are over \$45,000,000. Probably the aggregate commercial and trade transactions of Utah amount to \$200,000,000 annually.

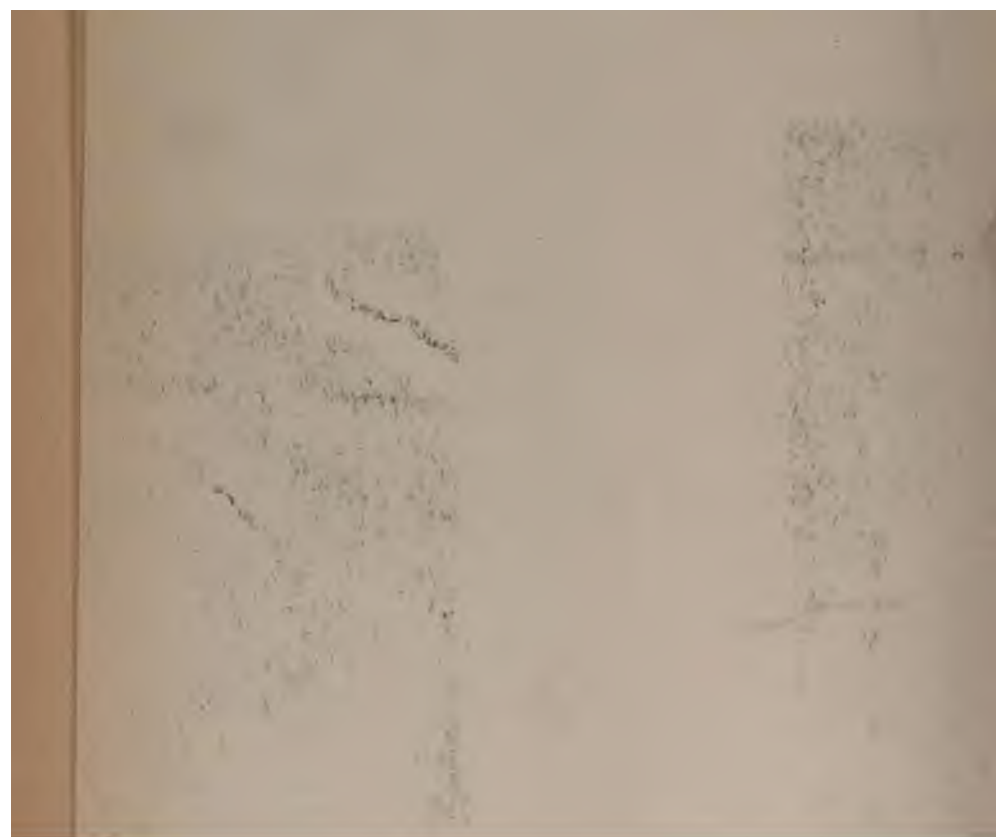
INDUSTRIES—Utah will bear comparison with many older states in the number of its home industries and the spirited support given to them by its people. During the past year particularly, there has been a drawing together of those engaged in industrial pursuits, and a warm response on the part of the people to encourage and support them. Great woollen mills are located at Provo, Salt Lake and other points, employing large forces and consuming a considerable proportion of our native wool. Their output is quickly purchased, and the industry is by no means developed to its fullest capacity. Cassimeres, dress goods, flannels, blankets, yarns, etc., are made by these concerns, and compare in quality with the best that are imported. Boots and shoes, soap, clothing, pressed brick, canned goods, show cases and beer are among the largest of our manufactures. Many big flouring mills are now in operation in different parts of the Territory, some of them doing an export trade. The Utah Sugar Factory, whose works are at Lehi, is one of the biggest and best sugar factories in the United States. Its output is from four to five million pounds of excellent sugar annually. Factories producing silk goods, pottery, knit goods, confectionery, mattresses, crackers, vinegar, machinery, harness, tiles, upholstery, chemicals, pickles, iron fencing, etc., are now in operation in various parts of the Territory. Opportunities exists for the profitable establishment of other branches of manufacture, among them the making of white lead, gunpowder, whiting, iron pipe, sewer pipe, window glass, bottles, soda-ash, putty, starch, candles, paints, etc. For the manufacture of these articles large supplies of crude material are native to this country, and may be had at a low cost.

MINING—Computing at seaboard value, the production of gold, silver, lead and copper in Utah in 1893 was \$12,832,074; besides this, there exist in greater or lesser quantities, bodies of zinc, cinnabar, bismuth, antimony, manganese and other metals

scattered through almost every county in the Territory. Aside from these metals, it has been proven that Nature has stored up within our boundaries vast treasures from which manufacturing and commercial communities may draw their supplies of crude material. In this respect it has been truly said that no other state in the Union possesses a more diversified or valuable store. Among the mountains and valleys are deposits of alum, asbestos, asphaltum, barytes, borax, hydraulic cements, chromium, clays, copperas, coal, mica, nitre, onyx, petroleum, phosphates, plumbago, precious stones, pyrites, salt, soda, sulphur, talc, thermal springs, whetstones, lithographic stone, slate, building and ornamental stones and marbles of great variety, and probably other minerals which no doubt exist in the portions of the Territory that have not been closely explored. Many of our mineral products excel in quality and quantity those of any other region. Utah's iron resources certainly exceed those of any other section of the Union. The sulphur deposits are far richer and more abundant than those of Sicily, and could easily supply the commerce of all nations. The finest quality of salt exists in boundless quantities. The Wasatch Asphaltum Company at Salt Lake City is shipping to all parts of the United States the finest grade of pure asphaltum that has ever been discovered. Until their deposits in eastern Utah were put upon the market, the highest grade of varnish manufactured from asphaltum gum was imported from Egypt at a high price; but now, all the best black varnish made in the United States has Utah's asphaltum for its base. Trinidad asphaltum is 30% bitumen, Cuban is 40 to 60%, Egyptian, 80 to 90%, Utah's is 99.9% pure as taken from the ground. An account of the total resources must necessarily be incomplete to find bare mention in these pages; suffice it to say that when due consideration is given to our climate, agriculture, water supply, horticulture, ranch and range, mining industry and commerce, added to our many attractions as a resort and our magnificent scenery, Utah can safely challenge comparison with any other region in the world in the variety, extent and value of her resources and possibilities.



MAP OF A TYPICAL UTAH FARMING TOWN SHOWING LOCATION OF IRRIGATED FIELDS ADJACENT.



CO-OPERATIVE IRRIGATION.

BY JOEL SHOEMAKER, IRRIGATION JOURNALIST, MANTI, UTAH.

Utah irrigation systems have many peculiarities, which commend them to the admiration of practical man in every irrigated country. The adaptability of these systems to all classes of farmers and to almost every section of irrigable lands within the Territory, and the united actions of shareholders in canals, are characteristics noticed more in this, the coming populous and prosperous state, than in any irrigated division of our continent. Men have organized colonies, entered upon desert wastes, removed the native sagebrush, leveled the fields and made perfect bowers of Eden by the aid of irrigation canals, and, without incurring any indebtedness, floating any bonds or expending any great amount of money in the work. This has been accomplished by means of a system of co-operation inaugurated by the Pioneers of Utah and practiced by their successors, whether Mormon or Gentile. It has been the governing principle of Utah colonization that labor should constitute the basis of stock in every canal, and in all the original colonies this rule has been strictly enforced.

In the beginning of the work of conquering the deserts by the powers of irrigation, people were forced to huddle together in stone forts, erected as protection against Indian depredations. The principles of mutual interests were fostered by reason of existing conditions, and humanity in its best form was fully developed, in training the colonists to protect one another and lend a helping hand whenever necessary. Town plats were laid out round these common enclosures, and lots were drawn by numbers. When the Indians had been driven away, the colonists proceeded to construct dwelling houses upon the lots obtained through the common division. Entries were made upon tracts of land adjoining these town-

sites, and, by one of the methods of obtaining title to government land, each colonist secured one quarter section or more of the tillable area. The native meadow land, if such was within range, was divided in proportion to the actual settlers desiring the benefits of pasture or hay. The range of public domain became the property of the entire colony, and was used for horses, cattle and sheep, as agreed by a majority of those interested.

The townsites were located on some living mountain streams, having a sufficient flow of water to supply the demands for irrigation in the fields and for culinary purposes in the settlements. By common consent, the city or town authorities have assumed the powers of controlling and distributing the water, both in the corporate limits and in the fields. This method, though not always strictly legal, has proven the most economical and satisfactory plan for general distribution of water of any yet suggested. When no council has existed, the entire people constituted a committee or directory, and employed a watermaster on an annual salary, or with the understanding that the distributor should be paid by levying an assessment on a ratio of acreage under cultivation. The watermaster thus appointed, has usually been paid in the crops grown by the farmers benefitted by the distribution. In some sections, the cost has not exceeded fifteen cents per acre for one year. The annual assessments for keeping canals in repair have been paid as in the first or building expense, by making labor the chief means of payment.

No very extensive irrigation canals have been constructed on the plan outlined above, but scores of ditches, extending for from four to ten miles, and covering sufficient acreage to supply the demands for two or three country towns, have been built by this system. Weber County is one of the most prosperous and populous sections of the Territory. This county has no less than sixteen canals taken from its two rivers, and several small towns, lying ten miles from the streams, besides some ditches carrying water from creeks, all of which have been made under the co-operative plan, originated by the Pioneers. The primary costs of these ditches or canals is estimated to have been about fifteen dollars per acre, and

the annual distribution expense, including keeping canals in repair, does not, in any case, exceed one dollar per acre. This first cost is figured at the wages paid at the time the canals were constructed, and is more than double the prices paid for such labor today. While labor was made the basis for commuting shares of stock, some men were given certificates in exchange for lumber used for flumes and timbers and stone used in constructing dams or making bridges for travel.

The beneficial results of colonial organization have extended to every economic and social condition and made the people better in all respects. The public lands, including the mountains, valleys and non-irrigable tracts, have become the common property of all, and at the same time received the protecting oversight of each colonist. Watersheds have been protected, the forests have been carefully preserved, and the fouling of streams has been guarded by all, because of the very fact that the co-operative systems include the entire population, and no one is exempt from more or less responsibility in everything that pertains to individual or colonial wealth or happiness. Better social and financial conditions have been adopted, and the civilization has taken a higher plane by reason of such colonization. The homes have been more comfortably and conveniently constructed. Architects have vied in designing, and various types of beauty, symmetry and finish have attracted the attention of the stranger in Zion. The demands of society have compelled a more thoughtful recognition of personal appearance, and thus Utah has taken first rank among the new territories for the refinement and education of her young people, who have carried away premiums from almost every college.

This co-operative system has been carried into the commercial avenues of the people of Utah. In every settlement, the principle of co-operation is practiced, by the organization of mercantile and other corporations. Salt Lake City has its Zion's Co-operative Mercantile Institution, one of the largest business houses of the west. Its branches extend to many smaller cities and towns throughout the Territory. A large shoe factory is conducted on similar lines. The famous sugar factory at Lehi is the result of

this school of co-operation. In every grade of business, such organizations exist. The farmers unite in shipping a trainload of wool, wheat, potatoes or stock, and form local companies for the purchasing of farming implements or machinery at wholesale prices. Individual efforts are not stultified, but men are encouraged in every legitimate undertaking. The very fact that co-operation is a success, acts as a stimulus to individual ambition, because the personal worker realizes that by honesty and integrity he will gain that universal respect and confidence so easily dispensed or withdrawn under co-operation through fair or fraudulent dealings. All the successes attending co-operation in Utah, might easily be attributed to the first school, the beginning of all wealth in Utah—*irrigation*.

A few large irrigation enterprises, requiring the investment of great sums of money obtained by selling bonds, have been constructed in Utah. The Bear River Canal covers an immense area of irrigable land, now in an arid condition, subject to entry and purchase under the desert land law. This system has cost over two million dollars, and will furnish a water supply for several most excellent locations for the formation of colonies. The water is furnished by the company as a perpetual auxiliary to the land, and only a small annual rental is charged. Hundreds of happy homes will soon ornament the banks of this great canal, and thousands of strangers to irrigation methods will learn the power of water in land reclamation, and become familiar with the practical work of colonial organization. The Swan Lake, Beaver Valley and Snake Valley Companies own large bodies of land, which are being put under cultivation. They represent the results of investigation by eastern capitalists of the successful efforts of colonization as practiced by the citizens of this Territory.

Many opportunities for canal building are open to the investor, who is seeking a profitable field in the coming State of Utah. Large tracts of land now lie in the native desert condition, awaiting the revivifying power of irrigation to transfer them into fruitful fields. The Rio Grande Western Railway, a complete Utah road, with all its branches, penetrates some of the most ex-

tensive deserts, and invites men and capital to its side to assist in reclaiming several hundred thousand acres of the best land in the West, by constructing reservoirs and canals for irrigation. The Union Pacific road crosses some parched deserts, where, by the use of water, even semi-tropical fruits and nuts may be produced. Nature smiles upon the scene and invites the attention of wide awake citizens of the uncertain rainbelt to seek the rich treasures of irrigation. No drouths, cyclones or hurricanes disturb the peaceful inhabitants, and the Goddess Irrigation peers forth amid bounteous crops and abundant harvests, and bewitchingly shouts to the weary rainbelt traveler, "Come to the land where Irrigation, and her sister, Co-operation, dispel all doubts and make success a surety. Come wed these sirens and your days of unhappiness are over."



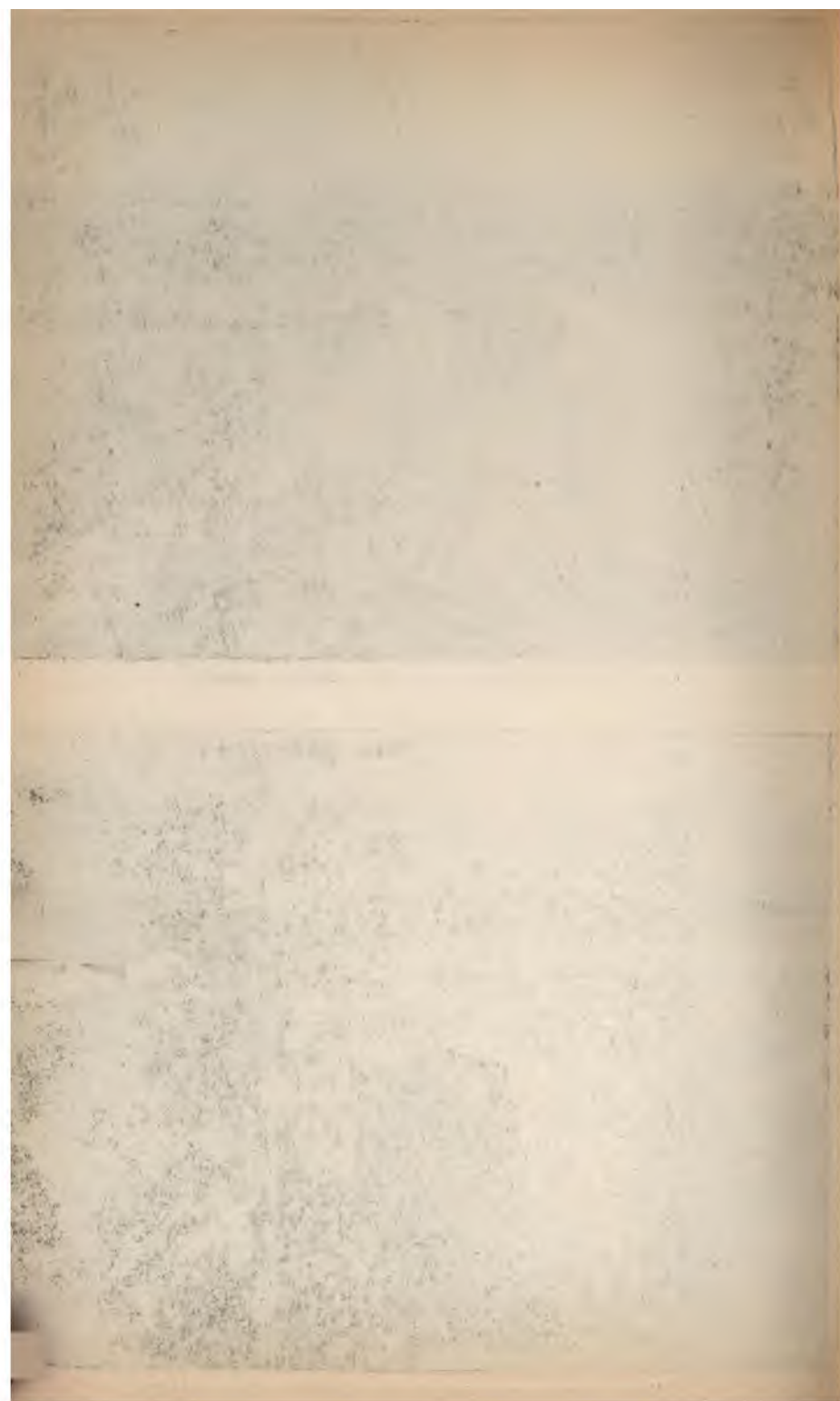




VIEW AT OUTLET SEWER, SALT LAKE CITY SYSTEM.



VIEW SHOWING CONSTRUCTION, SALT LAKE CITY OUTLET SEWER.



UTILIZATION OF SEWAGE IN RECLAIMING ARID LAND.

BY A. F. DOREMUS, CHAIRMAN BOARD OF PUBLIC WORKS,
SALT LAKE CITY.

The application of sewage to land is now regarded as the most efficient means of purifying or disposing of the sewage. The profitable utilization of the sewage through such application is, however, not so well established, although it is successfully employed as an aid to agriculture by many of the large cities and towns in Europe.

Practically, all the experiments which have been made in the use of sewage in connection with the cultivation of the soil have been conducted upon land in the humid regions, where the necessity for irrigation is unknown, and as might be expected under such conditions, the result has been that, while it has established the superiority of land over all other agencies in the purification and disposition of sewage, and exaggerated the value of the solid portions of the sewage as a fertilizing element, the value of the water, which constitutes about ninety-five per cent. of the sewage, has been greatly underestimated and generally wasted into adjacent streams or lakes as worthless, after having been relieved of the solids, which constitute the remaining five per cent. of the sewage.

These experiments have also demonstrated that fertilizing elements applied in liquid form, as in the case of sewage, are more readily and completely assimilated by plants than when used in any other form, and that the high temperature of the sewage, as compared with water ordinarily used for irrigation, serves as a stimulant in forcing the plants to greater and earlier maturity. This latter fact will be fully appreciated by every practical irri-

gator who has already been taught by experience that the application of cold mountain water produces the opposite effect.

The result of these experiments also shows to what degree sewage may be utilized in regions where there is sufficient rainfall to meet the requirements of successful agriculture, and invites the suggestion that the arid regions alone afford conditions which are entirely favorable to the complete and profitable utilization of this troublesome waste matter, which, in humid regions, becomes a nuisance and its disposition the occasion of much concern, as well as expense.

In Utah the conditions are especially favorable to the use of sewage for irrigation. Nearly all the towns and cities occupy the higher lands at the base of the mountain ranges where the streams issue which supply water for culinary and irrigation purposes. The lands below are smooth and slope gently away from the mountains. The soil is rich in all the elements necessary to its profitable cultivation, with the sole exception of moisture, and lacking this, it is without practical value. All the land has been reclaimed for which water for irrigation is available at moderate cost, so that there remains in the vicinity of every town and city, much of this worthless land upon which the sewage can be easily conducted and profitably used.

Already important steps have been taken to apply sewage to this class of land. At Salt Lake City the great masonry sewer, which is about seven miles in length, and which has been under construction during the past two years and is now nearing completion, has its outlet upon a tract of barren land embracing several thousand acres, which it is proposed to reclaim and bring under the highest possible state of cultivation by means of irrigation which the sewer affords.

As there is no other available supply of water for the irrigation of this land, its reclamation and cultivation is impossible, except by means of the millions of gallons of sewage which will be discharged upon it daily, and which without the land would also be worthless. Here most certainly will be witnessed a wedding of the worthless where profit is the progeny.

Any fear that injury to health will follow the use for food of plants that have grown in contact with sewage is without reason, as it has been demonstrated beyond all question that cabbage, turnips, parsnips, beets, celery, asparagus, melons, strawberries, and similar food plants and berries that have been grown upon the sewer farm, are superior in quality and healthfulness, and command the highest prices in many European cities where they are extensively used. The local Chinese gardener applies his liquid fertilizer most liberally to fully develop and make more salable his "truck," against which there is no prejudice, neither should there be, on this account.

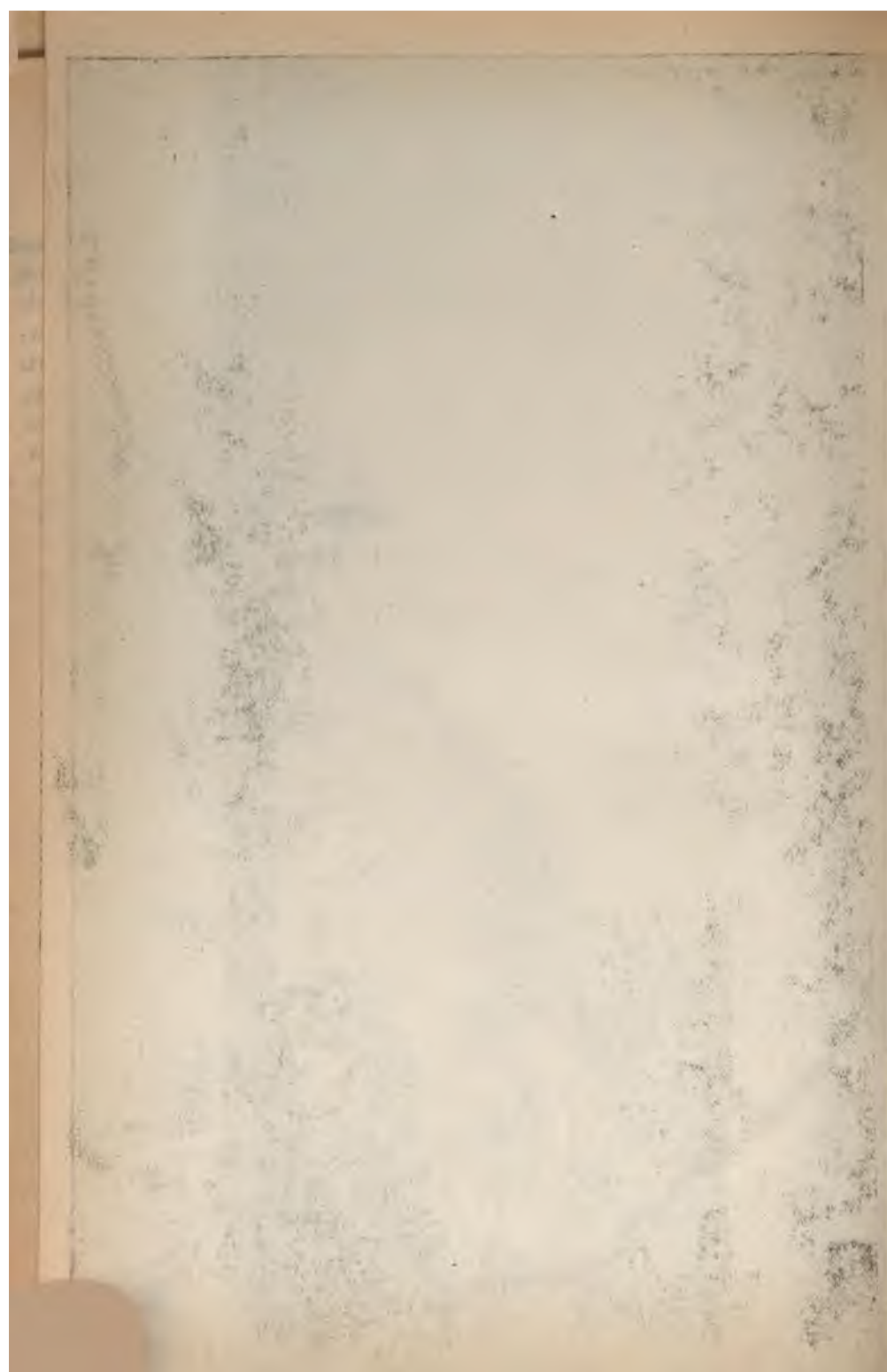
All the forage plants and all kinds of grain and vegetables, as well as fruit trees, are greatly aided in their development where liberally supplied with sewage.

The result of the Salt Lake City enterprise is being watched with a great deal of interest both in and out of Utah, and the plan will, no doubt, be copied by other cities and towns that are similarly situated. Success in the profitable use of sewage for irrigation is simply a matter of intelligent management, as the experimental stage has long since been passed. The rainy regions have discovered a use for the solids, and the rainless regions know what to do with the water.

Among the many possibilities which the use of sewage for irrigation suggests, is the inducement to construct sewers in towns and cities throughout the rainless regions long in advance of the time when such work would be undertaken as a purely sanitary measure, with the resulting advantage to health, and the profitable employment of additional capital and labor in sewerage and farming operations.

The subject forms a most interesting study in economics, and is one which must attract attention from the engineering fraternity especially, and from municipal authorities and others who have under consideration plans for the irrigation of land or the sewerage of cities.

Salt Lake City, Utah, November 20th, 1894.



HOW THE IRRIGATION AREA IN UTAH AND THE WEST CAN BE INCREASED.

FROM THE LEGAL STANDPOINT, BY JUDGE C. S. KINNEY
OF THE SALT LAKE BAR.

AN ADDRESS BEFORE THE THIRD IRRIGATION CONGRESS.

What is it that brings representatives from every State and territory of the arid region together in this assembly. It is because the rainfall is not equal over all the earth or even over the so-called arid region. It is because Congress, unlike its neighbor at the north—the Canadian Parliament—in framing the land laws of the National Government, failed to grasp the idea that the water flowing in the streams over the public domain within the arid region was of any particular value. It is because Congress in passing these laws failed to recognize the fact that, owing to the physical and topographical conditions of this part of the country during the winter season, great masses of snow are piled up in the mountains and remain in these storehouses of nature until the summer's sun causes them to gradually melt into water, which runs down into the canyon streams, then from the mountains, where it is finally wasted in the sea. This water, in its journey to the sea, by remaining in its natural channels, passes through a vast extent of dry valleys, the soil of which is naturally fertile, but where the moisture, instead of being precipitated nearly equally over this part of the country, as is the case in

what is known as the rain belt, is gathered in channels which touch only a very small proportion of the land.

CONGRESSIONAL REMISSNESS.

Although Congress has appropriated millions of dollars for internal improvements of various kinds and for river and harbor schemes, it has yet failed to appropriate money to dig one ditch or to build one reservoir to store the flood waters in order that they might be conducted upon the land when they were needed during the dry season of the year. Its labors have ended with geographical and topographical surveys. Hence the making of laws governing and controlling waters within the arid region has been left entirely to the individual States and Territories within that region, and the promotion of irrigation schemes entirely to private enterprise, with the exception of what assistance some of the States have rendered.

Why are we here, did I ask? We are here because many of the State and Territorial legislatures have been unequal to the burden that has been thrust upon them. However, the legislatures of a few of these States, of which California, Wyoming and Colorado are the leading examples, have made mighty strides in the direction of perfection by enacting drastic codes of laws upon the subject of waters best adapted to their respective conditions.

Why are we here? Because our neighbors below us on the stream, from which we all have heretofore appropriated the water, have accused us of illegally diverting some of its waters that they lay claim to, and they have brought a suit against us; and we are here to learn how we can get out of the scrape.

THE BEGINNING.

We, from Utah, as far as the laws governing this subject are concerned, come as learners. Upon the eve of a Constitutional convention at which will be adopted a Constitution that will form the basis of all the laws of the future State, we come to listen to the words of wisdom upon this subject from the lips of the able representatives of our sister States. We have learned much. We

shall learn more. We shall go home strengthened and enlightened. We shall endeavor to induce the convention to adopt Constitutional provisions upon the subject of waters which shall be the basis of just and equitable laws upon that subject, which is paramount to all others as regards the welfare and prosperity of our future State.

But as far as the practical workings of irrigation are concerned, we can be counted as teachers. It must not be forgotten that the first irrigation in this whole region, by an English-speaking people, was practiced by the pioneers of Utah, and upon the place where Salt Lake City now stands. To those men must be given the credit for the first starting of this great work. We have splendid streams of water. We have broad and fertile valleys under the most complete cultivation. Our Territory is teeming with cities and towns that have sprung up in these valleys. We are a happy and prosperous people, now entirely united for the advancement of one end—the prosperity of our future commonwealth.

To be sure we have a few lands that are yet unoccupied, and, of course, uncultivated. We shall have more when we give to Colorado our Indians. Come over and see us and make your home there.

SCARCITY THREATENED.

As the country is becoming more and more settled, the water supply for the area of land to be irrigated is each year becoming smaller and smaller all over the arid region. And, taking this part of the country as a whole, there are very few localities where, as in the past, a farmer can divert water unclaimed by others, and, by the means of a simple ditch constructed by his own labor and that of his neighbors, bring his farm under a system of irrigation. Hence it is, under this state of circumstances, becoming a very serious question, as to from what source the additional supply of water to meet future requirements is to come. How can the water supply be increased so as to bring more land under cultivation?

The simple, but important fact that the area which can be irrigated is dependent upon the amount of water flowing in the streams, is often ignored in the general discussions of irrigation and its possibilities. It is often taken for granted that simply because there are vast areas of fertile land along a river, some of which has been irrigated profitably, larger and larger areas will, with the progress of settlement, be brought under cultivation to an indefinite extent. The assumption cannot be correctly made that since a river of a certain locality occupies a large space on the map, and actually drains a large area of land, that the waters, without a storage system, must be proportionately abundant. It is unfortunately the case that many of the rivers of the arid region, although of considerable size in the winter and spring, carry but a very small amount of water for at least the cropping period of the year, and then the water is utilized and actually needed for the irrigation of the land now wholly or in part under cultivation.

FIVE METHODS.

As I view the subject, there are five methods by which the present water supply may be increased, or better distributed, so that an additional acreage can be irrigated. They are as follows:

First—By cession to the States of the lands capable of being reclaimed within their respective boundaries.

Second—By storing the flood and waste waters of the non-irrigating season so that they can be used when required in the summer.

Third—More artesian wells must be sunk in those regions where they are possible, so as to irrigate certain lands that are still wholly barren, and to help out in the water supply of others only partially irrigated.

Fourth—An enormous increase in acreage cultivated by irrigation can be accomplished by vast systems of canals to divert the waters of the larger rivers of the country.

Fifth—But by no means least, it is possible to enact more stringent laws to compel the greatest economy in employing the

water and to prevent waste, in order that the supply obtained may cover larger areas of land.

CESSION ESSENTIAL.

Taking up the first topic, let me say that under the existing circumstances I fully believe that the transfer of the arid lands to the States to be essential to the most complete success of our irrigating systems, and the fullest development of our agricultural resources. Congress, by recent enactment, has taken a great step toward the accomplishment of this end. It was a step that arose from the very necessities of the case. How the millions of acres of arid land in the west could best be reclaimed was the question to be determined. Whether it should be by the cession of the public lands to the States and Territories in which they lie, or whether it should be by additional Congressional legislation governing the appropriation of the waters and of the reclamation of these lands.

Then, also, Congress had this to consider. As the population increased in this part of the country, the readily irrigable and hence more valuable lands were being rapidly taken up, and desirable localities were becoming more scarce. Land in this part of the country without water is, to all purposes, as far as known, except where it contains minerals, absolutely worthless, although the quality of the soil itself may be quite as good or better than the soil that is now within the reach of water and under cultivation. The possession of the arid lands will enable the States to exercise a systematic supervision over the diversion and use of waters, and will endow them with resources to assist in the construction of storage works or the utilization of waste and flood waters, and will aid in the construction of works too great in magnitude and cost to be undertaken by private enterprise.

BENEFICIAL EFFECT.

Again, what effect will this cession of the lands have upon future State legislation upon the subject of waters? Undoubtedly the land and waters in the public domain, being joint elements and

both necessary to success, should be under one control, and whether this control should be vested in the State or the United States, is the pertinent question. Both methods have their advantages and their disadvantages. If, in the beginning of the settlement of the arid region, the United States Government, as the Canadian Government did, had exercised the same supervision over the diversion and use of water that it did over the settlement upon its lands and the acquisition of title thereto, there might have been no question as to the wisdom of the General Government continuing in the ownership and control of the lands and waters upon the public domain within the various States. But its failure to take any steps to secure the economical use of waters, or to protect the rights of parties diverting them and applying them to beneficial uses, has forced upon each State and Territorial government the necessity of exercising such control and supervision. The result of this has been that these various States and Territories have built up their own codes of laws as to these matters, which form the basis and protection of property rights of enormous value and importance within their respective jurisdictions. That these laws differ greatly in the different States we have only to refer to their statutes to ascertain.

I am of the opinion that they should differ. The States themselves differ greatly in climate, physical and topographical features, and especially in their water supply. Laws should be enacted that are best adapted to these various conditions. And in all the arid and sub-humid States and Territories, laws of some description have been passed upon this most important subject. Any attempt upon the part of the United States at this late date to formulate a uniform system of laws that would be applicable to the whole of the arid region, were it possible, which it is not, would involve the present irrigation interests in untold confusion. Upon the other hand, should the question be left entirely to the States, they should be given the necessary authority and placed in the possession of resources most speedily and effectually to accomplish this work.

I am aware that the delegates to this congress greatly differ in their views upon the subject of cession of the lands. The great



The golden Provo Valley.



bugbear of corporations grabbing these lands is held up before us. The subject seems to have resolved itself into this question: "Are we afraid to trust ourselves?" Do the people of this part of the country know their own needs and necessities, or must we have them doled out to us by the New England States? I believe that the great states of Colorado and California are fully able to manage their own. I believe that the people of Wyoming have a sufficient appreciation of their needs to prevent the cattle companies from turning that State into a vast "pasture land," as one of your local papers this morning said. As for my own Territory, with an average agricultural holding of twenty-seven acres, I know that we are strong enough to enact such laws, relating to the settlement of these lands and the acquisition of title thereto, as to be for the best interest of the bona fide settlers.

Upon the other hand, if it is the corporations that we fear, what is to hinder their grabbing these very lands for which we are asking under the present desert land laws enacted by Congress?

I will only add in this connection that I do not fear these corporations as do some of the members of this congress. It must be conceded that it now requires a large amount of money to build works that cover any great portion of land. What is the object of these corporations investing hundreds of thousands of dollars in these works? Is it not to get returns for their investment by the sale of property rights acquired? And will not the law of supply and demand govern the price of these corporate lands and waters as in other cases?

STORAGE RESERVOIRS.

The adoption of systems of storage reservoirs for the conservation of the flood waters now going to waste, is the second method by which the irrigated area can be increased. Irrigators look forward to this method as one of the most effectual means of obtaining relief from present troubles and uncertainties. Progress in this direction will, however, be necessarily slow, from the fact that in an undertaking of this kind, the outlay of capital, before any return can be realized, must be very large. Efforts have

been made in the past to have Congress at least assist in the building of these reservoirs, but without avail. Nothing was done with the exception that a portion of the country was resurveyed, and certain reservoir sites were located by the Government without being developed, which only prevents private parties from locating and developing them.

Without storage systems, water enough to irrigate thousands of acres of lands runs to waste during the winter and spring down each one of these canyon streams. It should be stored up for use in the summer season, when it becomes of inestimable value at a time when the stream itself is so reduced in volume as to be insufficient to supply perhaps two or three farmers who lay claim to its waters by prior appropriation.

There are necessarily legal complications that must be decided before any large scheme of this kind can be successfully projected. On nearly every stream throughout the arid region, more water is claimed than naturally flows in the same, and when a company builds a reservoir and stores the flood waters, and restores these to the stream in time of drouth, the question at once arises, to whom do these waters legally belong? The prior appropriators upon the stream must be looked out for, especially if to bring it upon new desert land, the stream by which this stored water was conveyed, flows by the head works or diverting dams of a number of ditches, the owners of which are in need of water, and claim an appropriation of the waters of the stream to an extent much greater than they were then using. Before any such scheme can be successful, it is necessary to ascertain, not only the amount of water naturally flowing in the stream during the different seasons, and all claims of appropriators thereto, but also the amount of water by the respective individuals actually applied to some beneficial use or purpose. There is often a wide discrepancy between the quantity of water which a man claims by virtue of his appropriation, and that which he actually receives, for his recorded claim may apparently give him more water than flows in the stream during the summer months, while he actually uses but a small portion. If, therefore, the company storing the water were to

supply all those having claims to the stream, there would often be none left for the company's use, and consequently the storage enterprise would be a failure.

RIGHT TO ACQUIRE WATERS.

Fortunately for the irrigation companies in all the States, they have the power of acquiring the exclusive rights to water of the streams, lakes or other sources of supply, and of storing and conducting it to the place where it is to be applied. There are several methods by which these rights to water can be acquired. One is by the direct appropriation of the water, either in individual or corporate names. These appropriations, of course, under the general rule of the arid region, if they are prior in time, have the superior right. But if other rights have vested in and to the waters of a certain stream or lake prior to those of the company, its appropriation is subsequent and subject to them. Identically the same rules apply as govern appropriations between private individuals.

Another method by which water rights may be acquired by these companies is by special legislative grants. The rights granted, however, must be in waters owned by the State, and also subject to all prior vested rights to the same. The third method is by purchase from the prior claimants. The fourth method is not universal. In some of the States there are legislative provisions giving rights by means of special condemnation proceedings. This right, however, is not allowed in all the States, and in Nevada it is expressly forbidden by statute. I will refer to this last subject later.

CO-OPERATION NEEDED.

Agricultural developments, therefore, by the use of stored water, must rest to a great extent upon the cordial co-operation of all parties who are at present enjoying the use of water from the same source. The difficulty of such co-operation is fully appreciated by the people of the arid region, and many plans have been discussed for bringing about, either by having the State control all

the waters within its jurisdiction, which plan has been adopted by the States of Colorado and Wyoming, or by the formation of irrigation districts exercising certain powers, an example of which is the California district law. The great stumbling block is the fact that so many individuals of different minds and opinions have property rights in the waters of the streams. That the various owners of the waters do not at once co-operate in some of these plans, is not to be laid wholly to individual cupidity or lack of public spirit, although I think that I have heard of cases of that nature. The fact is, that to each irrigator this matter is of most vital importance. The value of each man's property appears to be at stake, and that which he has acquired by long years of toil and hardship is not to be given up at once on any plea of good to the community, especially if to him the benefits to be derived seem doubtful and uncertain. The farmers also have a natural fear of being in some way imposed upon in making any radical changes, and are harrassed by the dread of falling into the grasp of monopolies, and thus, perhaps, prefer to endure present evils rather than to encounter those which are unknown.

ARTESIAN WELLS.

Upon the subject of waters from artesian wells, I will simply say that they are a valuable adjunct to the rainfall of the waters from natural streams. There are many advantages also in a farmer owning his own source of supply, instead of having to depend upon ditches or canals to divert the water from natural streams, the waters of which may be claimed by others. In fact, the more that I study upon this subject, I think that if he could fix it up so that he could have a stream of water flowing from his own well or spring, and sinking on his own land so deep that his neighbors could not get at it, that it would often keep him out of difficulties. They would make him no trouble about riparian, prior or other rights.

But statutory laws must be enacted so that the waters of artesian wells shall not be allowed to run to waste. It has been ascertained from experience that when there are a great many of

these wells in the same region, many have gone dry, while the flow of others have been materially lessened. The Legislatures of several States have enacted laws providing that when the flow is not necessary for use, the well must be shut off, and prescribe severe penalties in case of failure to do so.

DIVERSION OF RIVERS.

The fourth method of adding to our supply of water in order to increase the acreage that may be cultivated, is the construction of large and expensive works to divert the waters from the large rivers. Although in the arid region there are a great many small canals which take the waters from the inferior streams, there are very few canals that take the waters from the large rivers. These works can only be constructed at enormous cost, and eventually, the Government will either have to undertake their construction, or offer some special advantage to induce private enterprise to do so. Although we have no such rivers in the arid region as the Ganges in India, from which are taken canals that run thousands of miles in length, still, we have a few, as the Columbia, Missouri, Rio Grande and Sacramento, that discharge large volumes of water, much of which may at some future time be utilized. There is no doubt but that in the matter of irrigation we are behind Europe, Asia, and even Africa, not only in the extent of our works, but in their cost and engineering features. We are not only behind the modern nations of the Old World, but we are also behind the marvelous nations of antiquity.

The explanation of this is, that the time has not yet arrived when the question of irrigation has become a great national question and necessity, as it has in the more densely populated countries of the Old World. But, leaving this topic for the discussion of the civil engineers, irrigation scheme promoters and the capitalists, I pass to the last, the suppression of wasting waters.

AMPLE POWER.

There is no doubt as to the power of the legislatures of the States and Territories to enact laws, as many indeed have done, for

controlling and supervising the distribution of water taken from the streams running within their respective boundaries, and thus prevent the appropriators from wasting water by diverting more than is actually needed for the purpose for which the appropriation was made. State Engineers, Boards of Control or Irrigation Commissioners have been provided for this purpose by some of the States, the duties of which officers are, as their names indicate, to control, supervise, and in some States, adjudicate all questions relating to waters and water rights. The laws of these States also provide that any one dissatisfied with the decisions of the Board, can have resource to the courts. But, especially of late years, when every year the area of land for which water is needed is constantly increasing, and the available supply of water is constantly diminishing, it has been the policy of the legislatures, and of courts—if it can be said that courts have a policy—so far as possible to suppress all wasteful methods in the diversion and application of waters. In the early days, a prior appropriation was deemed to cover all the water in sight, whether it was needed or not. There are many appropriators who still demand the amount of water claimed by them at first, although that amount is many times more than is actually needed by them for the purpose to which they apply it. Having no knowledge whatever of the proper use of water as an aid to agriculture when they first made their appropriation, and there being at that time an entire absence of any written authority upon the subject from which they could learn, and water being plentiful, it followed as a matter of course, that the settlers adopted very wasteful methods in the use of it. Many of these settlers still keep up their wasteful methods, notwithstanding the fact, demonstrated by practical experience, that by so doing they are raising smaller and poorer crops than they could have raised by using the water more sparingly. In many places it has been shown that from a given stream, five or six times as much land could be irrigated as had been thought possible in the early days. But, even with the present laws for the prevention of these wasteful methods, the natural flow of the streams is becoming daily more inadequate to meet the demand, and, finally,

it has become apparent to all, that if the progress of the irrigation development is not to be seriously checked, more stringent measures will have to be enacted. Now that these possibilities have become known, and the population of the arid region is so rapidly increasing, there has come a time when so many want water for irrigation and other purposes, that some systematic plan is demanded, and has to be settled upon for its distribution other than the wasteful methods, or rather a lack of methods, that formerly prevailed. So the legislatures of a few of the Pacific States and Territories, and the courts of all are tending to put an end to these selfish and wasteful methods, and follow more strictly for their basis the principle of "beneficial uses."

AN EXTREME CASE.

But, in speaking of the courts, I will say that they have not all gone to the extreme that a District Judge in Idaho recently went, in the case of *Hillman vs. Hardwick and others*. If they had, and the Almighty would execute their judgments, there would be a sixth method of increasing the acreage under cultivation in the arid region, and that would be by increasing the water supply by judicial decree. In that case the evidence was that there were about eighty to one hundred inches flowing in a certain stream, and the plaintiff claimed by virtue of a prior appropriation, 125 inches of water. But in spite of the fact that his claim to this amount and his actual application of all of the water for the purpose of irrigation were both proven, the trial court rendered a judgment giving the defendants permission to divert something like 800 inches over and above the amount claimed by the plaintiff. Of course the Supreme Court of that State reversed the judgment below, and Mr. Justice Huston, in rendering the opinion, said:

"We then have this anomalous condition of affairs: A creek or stream flowing 100 inches of water, with appropriations of that water to the amount of 800 inches, in addition to the prior appropriation of the plaintiff of all the water of the creek and its tributaries. To the ordinary mind this might, and perhaps does, present somewhat a difficult problem for judicial solution, unaided

by the statutes ; but the learned District Judge found no difficulty whatever in reaching a conclusion as unique as it is unprecedented. We say unprecedented, because this question, under statutes identical with that of Idaho, has been decided so often in favor of the prior appropriator, that it has been generally considered, by both professionals and profanes, as a settled question ; as, for instance, the question has been decided up to 1889, twice by the Supreme Court of the United States, seventeen times by the Supreme Court of California, five times by the Supreme Court of Colorado, six times by the Supreme Court of Nevada, twice by the Supreme Court of Montana, once by the Supreme Court of New Mexico, twice by the Supreme Court of Utah, once by the Supreme Court of Oregon, and repeatedly by the Supreme Court of Idaho ; in fact, the decision of the learned Judge in this case stands alone. We have been unable by the most diligent search to find a precedent or parallel for it. Heroically setting aside the statute, the decisions and the evidence in the case, he assumes the role of Jupiter Pluvius, and distributes the waters of Goosberry Creek with a beneficent recklessness which makes the most successful efforts of all the rain wizards shrink into insignificance, and which would make the hearts of the ranchers on Goosberry dance with joy if only the judicial decree could be supplemented with a little more moisture. The individual who causes two blades of grass to grow where but one grew before, is held in highest emulation as a benefactor of his race. How then, shall we rank him, who, by judicial fiat alone, can cause 800 inches of water to run where Nature only put 100 inches ? We veil our faces, we bow our heads before this assumption of judicial authority.

“Evidently the Court assumed that Gooseberry Creek was as inexhaustible as the widow’s crust, or else that its decree possessed the potency of Moses’ rod. All the provisions of the statute in regard to priority of right incident to priority of appropriation are ignored, as are the sources and volume of supply.”

RIGHTS MUST BE RESPECTED.

From the ruling of the District Judge in the case it is evident



SHEEP CREEK CANAL: on Lodge Pole Divide



SHEEP CREEK CANAL: Dam in Indian Park.



that, in some parts of Idaho at least, all do not understand the arid region doctrine of the appropriation of waters. The rights of the prior appropriator must be respected. But water is too precious an article in the arid region to be permitted to run to waste, and the great weight of modern authorities hold that, where a person has diverted a certain portion of the waters of a stream, and permits a part of the water so diverted to run to waste, or fails within a reasonable time to use a certain portion of the water for some beneficial use or purpose, he can only hold that part of the water diverted which has been actually applied to some beneficial use; and his priority extends only to the quantity so used. Also the authorities hold that there has been no appropriation as to the water not used, and which ran to waste, but that that part might be subsequently appropriated and held by other parties, provided they took the proper steps, and they themselves applied it to some beneficial use or purpose, the final test in all cases being whether all of the water diverted is actually applied to some useful or beneficial purpose.

There is another law that might be enacted by the State legislatures that would tend greatly to the public good, and that is a law providing for special condemnation proceedings of private water rights by virtue of the right of eminent domain. All of the States have statutes providing for condemnation of rights of way for ditches, and in some cases reservoirs; but they should, in my opinion, go one step farther and provide for the condemnation of the water rights. This is a subject regarding which I know many here will take the opposite view; and I should like to hear its practicability thoroughly discussed in this session of the congress. California has been the foremost in taking this step, and but very few of the other States have such an act. Some of the State laws especially prohibit the condemnation of water rights, notably those of Nevada.

But throughout the Western country it very often happens that the location of perhaps a single appropriator upon a certain stream prevents the conservation and application of its waters to its utmost possibilities. He will not sell, except perhaps, at an

enormous price. He will not join with others in an enterprise of developing the waters of the stream so that more land can be brought under cultivation, and more homes made for other settlers. Like the dog in the manger, he simply rests on the prior location, and will do nothing himself nor permit others. Now, what is to be done in a case of this kind? Nothing can be done unless his rights can be condemned, under some provision of the legislature, which must also provide that just compensation shall be paid him.

The Constitution of the United States provides that private property cannot be taken for public use without just compensation. Hence it follows that the property must be paid for, and that it cannot be taken at all except for a public use. This leads to the question: What is a public use? Judge Cooley, upon this subject, says: "The question, what is a public use, is always a question of law. Deference will be paid to the legislative judgments, as expressed in enactments providing for the appropriation of property."

In a country like the arid region, where so great a portion of the land is susceptible of agriculture, if the land can be irrigated, it may well be said, in view of the climatic peculiarities and topographical distribution of land and waters, that the legislature is acting for the public welfare in making provisions for supplying its many farming neighborhoods with water. Indeed, in view of the climate and arid soil in this part of the country (and for this object, climate and soil may be properly considered), it is safe to say that the supply of water for such use may be that which the legislature may decide it to be—a public use. The judgment of the legislature that it is such will not, therefore, be disturbed by the courts.

PUBLIC USE.

The term "public use" is an expression of indefinite signification, and its application to the facts of any particular case is to be determined from the evidence. The supplying of water to a tract of agricultural land, though of many thousand acres in extent, if occupied by an individual proprietor, would be for his private

benefit, and not a public use; yet, the same tract of land might be so subdivided and held in individual proprietorship as to render the supply of water to it a public instead of a private use. It is not necessary that the entire public shall enjoy the use, or even that it be capable thereof, but the use must be capable of enjoyment by all who may be within that neighborhood, and there must be within that neighborhood so great a number of the entire public as to destroy its character as a private use.

But, as firmly as I am of the opinion that such statutory provisions for the condemnation of private water rights would be for the public good, I am also as firm in the belief that there are other laws that should be passed in connection therewith. A maximum water rate, with severe penalties for any over-charge, should be fixed either by the legislatures themselves, or by some board by them created. There should also be an act providing that canal and reservoir companies organized for the purpose of furnishing consumers with water for beneficial uses, should be compelled to supply the demands of all bona fide customers when they tender the rate fixed therefor, and when the water can be spared without injury to the prior rights of others. Some few of the States have these last two provisions, but many have not.

Again, laws should be enacted by the legislatures providing for the survey, measurements and calculations of the discharge of the streams. These should be made by the State Engineer or a special irrigation engineer authorized for that purpose. Records should be kept of these calculations, which records should be the property of the State.

Coupled with the last law, there should also be a provision for a record to be kept by some officer of the name and address of the various claimants to the waters of any stream; also the nature of the use on which the claim for appropriation is based; the time of the commencement of such use; the date of beginning the survey; the date of beginning the construction of works; the date when the same were completed; the date of beginning and completion of enlargements, if any; the dimensions of the ditch as originally constructed and enlarged; the date when the water was

A NEW IRRIGATION COMBINATION.

A RESERVOIR SUPPLIED BY ARTESIAN WELLS ON THE SHORES OF
GREAT SALT LAKE.

Syracuse, Utah, is owned by the Adams & Kiesel Salt Company. It is situated on Great Salt Lake, nine miles south of Ogden and twenty-six miles north of Salt Lake City, and is reached by a spur running from the Union Pacific at Syracuse Junction to the lake. It comprises 1,200 acres of land skirting the same, and having a water frontage of six miles, and is the best and largest salt farm on the lake, having superior natural and artificial advantages. All along the lake frontage, and a short distance back from the shore line, there is a series of sloughs or basins which have been converted into ponds for collecting the salt. The land possesses several important requisites, adapting it to the uses to which it is being put, to-wit: salt manufacture, stock raising, growth of hay and grain, and a large variety of fruits, and especially to the growth of potatoes, sugar beets, cabbage, carrots, onions, strawberries, and an extensive vineyard, consisting of Concord, Niagaras, Catawbas, Delewares, Muscat and Tokay grapes. The manufacture of salt is by the "Solar Process." The water is pumped from the lake into large storage reservoirs, and carried into the sloughs by canals during the months of March to July inclusive, and the salt is harvested, as shown by the adjoining illustration, on tramways to the banks. The salt in this state is useful for the use of silver mills, and for salting stock and hides. Two or three trains of salt go out of Syracuse every week.

Utah has in operation four salt refineries. The impurities in salt made from Great Salt Lake are very light, not to exceed five



UTAH PHOTO CO.

STORAGE RESERVOIR—SUPPLIED BY ARTESIAN WELLS.
ADAMS & KIESEL SALT CO., SYRACUSE.

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ONION FIELD—ADAMS & KIESEL CO., SYRACUSE,



SYSTEM OF HARVESTING SALT.
ADAMS & KIESEL SALT CO., SYRACUSE.



THE HOUSE OF COMMONS



THE HOUSE OF COMMONS

per cent; such impurities being lighter than the salt, are very easily separated while going through the refining process by a series of blowers, leaving the salt, when refined, in a high state of purity, being over 99% pure. This refined salt is put up in neat packages consistng of two, three, five, ten, twenty-five, fifty and one hundred pound sacks, and is distributed all over this intermountain country, going as far northwest as Puget Sound, Portland, Pendleton, Spokane and Walla Walla, and east to Colorado points, and in all cases the manufacturers have met with a ready sale in competition with English salt on the west, and Kansas, Michigan and New York Salt on the east; the competitive line is drawn only by the freight rates. The manufacturers claim that there is a slight preference for Utah refined salt, owing to its high grade of purity and the fact that it does not cake.

After taking possession of this property for salt purposes, Messrs. Adams & Kiesel soon discovered that they had very valuable farming lands, and started to produce potatoes and lucern, and went extensively into shade tree planting, trusting to the irrigating canals supplied from the Weber River for watering their grounds. After working on this proposition for two or three years without any specially profitable results, owing to the fact that when they depended upon the irrigating canals for watering their grounds, they found that when they needed water the most, they could not get it, and when water was not needed, they would have an excess, and finally hit upon the plan of storing their water in large reservoirs for irrigating, as shown by the accompanying illustration. These reservoirs are all supplied by artesian wells as shown. They now have in operation sixteen of these artesian wells, that flow steadily the year round, and they are thus enabled to secure all the irrigating water at a depth of from eighty to two hundred and forty feet. They also have in active operation two "positive" artesian wells that flow into tanks elevated thirty feet above the ground. The first season that the storage reservoir was put into active operation, it demonstrated to a nicety that the reservoir system would prove a success on a large

scale, by bringing the land into a high state of cultivation and reducing it to a proper level.

They then went into the growth of cabbage on a scale of 80,000 head, large onion fields, carrots, sugar beets, asparagus, and 3,000 fruit trees, consisting of apples, peaches, plums, prunes, Bartlett pears and dwarf pears, and this year began to reap the results from this perfect system of irrigation as demonstrated during this season; for instance, water was turned on 190 rows of onions at one time, and the same method applies to cabbage and other vegetables. The reservoir is equipped with valves so that any amount of water can be drawn as wanted.

Messrs. Adams & Kiesel claim that experience has taught them that simply plowing up the land and running a harrow over it, putting in your seed and trusting to irrigation canals, proves a losing game from start to finish; but if a farmer will, in the first place reduce the land to a proper level, and set his reservoirs on a slight elevation, and thoroughly cultivate his ground during the growth of the crop, he will reap profitable results; and this applies to the growth of anything, whether it be lucern, potatoes or beets. What you want is the water on your crop at the right time and in proper quantity; and recommend the storage reservoir system no matter how supplied, whether by artesian wells or canals.

These enterprising gentlemen have also gone into the growing of Berkshire hogs on a large scale. They feel so much encouraged by the past success of the storage system that they are now preparing another reservoir to cover one hundred acres.

The home office of Adams & Kiesel Salt Company is with F. J. Kiesel & Co., Ogden, and Mr. D. C. Adams' office is at the Alta Club, Salt Lake City.



Concord, Niagaras, Catawba, Delaware, Muscat and Tokay Grapes.
ADAMS & KIESEL CO., SYRACUSE.



Garden Canal supplied from Storage Reservoir.
ADAMS & KIESEL CO., SYRACUSE.



FORESTRY IN UTAH.

It is admitted by all well informed people that irrigation in Utah has reached a high state of development. Perhaps in no part of the United States has the distribution of water for agricultural purposes been reduced to a system as completely as it has here been done. From the meagre statistics available, I believe it is safe to conclude that the arid lands of the west, which can be irrigated, will be quite as valuable for agricultural purposes as the corresponding lands of the east which are dependant on rainfall. Indeed, many careful observers of wide experience, have no hesitation in asserting that arid lands which are capable of being irrigated, possess a decided advantage over land dependent on rainfall. This opinion applies to land devoted either to agricultural or horticultural purposes. In the Mississippi Valley the only question of moment in regard to water is to devise means of increasing the rainfall and regulating its passage to the drainage streams; but in the arid belt, we are interested not only in increasing the annual fall of water, but equally, yes much more, in conserving that which falls until such time shall come as it shall be needed for our crops. The experience of the world serves to convince us that there is a close relationship between forest areas and rainfall. It is not difficult to understand how forests benefit a country from a climatic standpoint. Careful observations show that the air over a forest is a little cooler, and that it contains more vapor of water than the air over a plain. Hence the conditions are more favorable for the precipitation of rain over a forest when a current of moist air passes over it, than when the same passes over a desert. It has been suggested by some scientific reputation, that trees induce an electrical condition favorable to rainfall, but so little is positively known in regard to this, that in the present article it is only entitled to mere mention. In Utah,

as in all the rest of the Rocky Mountain region, our mountain forests are probably much more useful in securing proper distribution of water throughout the year, than in actually inducing an increased precipitation. With our mountains denuded of trees, the snows of winter will be largely blown into the canyons. The little which remains scattered over the surface will be melted by the first warm weather of spring and rush into the canyons, and from those into the agricultural valleys at a time of the year when water is little needed, or in many cases when it is an absolute detriment. The snow which collects in unshaded canyons will not last all summer.

When the mountains are protected by forests, the moss and leaf mold act as a sponge, taking up whatever water reaches them, and gradually giving it up to the soil, from which it reappears as springs, which unite their outflow to form brooks and rivulets, which are the water reservoirs of agricultural lands, as, when fed by springs, they flow evenly throughout the year, and furnish a supply late in the summer when it is most needed. While the most striking benefits of forests are more apparent in mountainous regions, still the forests on the plains are not without benefit. Experience seems to show that when plains are deforested, the level of the available subterranean water sinks, and aridity increases. It is quite possible that great floods are largely due to cosmic causes, yet the deforesting of the high lands must permit the waters to descend to the valleys much more rapidly than they otherwise would, and so the evils of the flood are exaggerated. That many of these evils, such as washing away of fertile soil, and depositing sand and gravel on arable lands, can be remedied by reforestation, is practically demonstrated by the experience of France and Tyrol. Volumes might be written on the preservation and proper use of the water supply of the world. It is not over stating its importance to say that it is the most important subject now before the people of the Rocky Mountain region. Last February the Utah Forestry Association was organized for the purpose of promoting the careful study of our forestry problems, and aiding in securing such national and state legislation as

may be needed to promote common interests. Just what national or state legislation we need is not fully known at present, but one result which should be attained as soon as possible is a national law which will forever protect and preserve the forest area around the headwaters of all streams.

In too many cases the timber around the headwaters of irrigating streams has been destroyed. In such instances proper national or state reservations should be made and the work of reforestation begun; but as prevention is always better than cure, our attention should first be directed to areas which simply need preservation. In the near future a large and valuable tract of country is to be opened for settlement in northeastern Utah. A study of the map of that region shows that four of the great irrigating streams of Utah rise within a few miles of each other in this soon-to-be-settled country. The streams are Provo River, Weber River, several large forks of the Duchesne, the Bear River, and a number of smaller streams. It is stated by those who profess to know, that extensive forests now surround these headwaters, but unless vigorous and decided steps are taken to prevent it, as soon as the country is thrown open to settlement, the forests will be destroyed, and the people of Utah will have to expend vast sums of money to restore in fifty years what they may now save without expense.

The interests of Utah demand that the subject of forestry be taken up in good earnest by men in all parts of the state, and that while we rush into no measures with undue haste, we act promptly so soon as we definitely know what is needed, and one thing which we may feel quite sure is required, is a permanent reservation in the Uintah Mountains which will protect the forest area around the headwaters of the streams I have mentioned.

With the pride which we all feel in our new State, surely we will not permit our future interest to be sacrificed for the sake of the petty gain to be realized from cutting the timber on the Uintah Mountains, where it is needed to properly conserve the water supply.

C. A. WHITING,
University of Utah. Sec. Utah Forestry Association.

The inhabitants of the inter-mountain region live in an arid climate, and they, and also the inhabitants of the semi-arid region east of the Rockies, have before them for their solution the great problems of irrigation. They are of all degrees of difficulty. The irrigation of small valleys from small mountain streams as has been, up to a recent date, practiced in Utah and Nevada, is a comparatively easy and simple thing, but the construction of immense reservoirs for water storage and the fertilizing of immense tracts of land by canals and high-line ditches from lakes and large rivers, are enterprises stupendous in their magnitude. Irrigation in this country has, however, reached the stage where such great works must be undertaken or development cease, and this is the condition which now confronts legislators, social economists, irrigation engineers, and any irrigation congress. How important it is that there should be no mistakes; how essential the great irrigation projects should be based on the facts of nature. Unless the hydraulic engineer works with an adequate understanding of the water supply he is to deal with, his work is largely experimental and much of it must result in disappointing and costly failure. Where is he to gain this desirable information? There are two methods by which the volume of the water supply of rivers, lakes and catchment basins may be computed. They are, briefly, current measurement and observation of rainfall. In my judgment, the best results will be obtained by combining the two methods; but if only one can be employed, I would consider the precipitation measurements as giving the most complete and satisfactory data, especially in calculating the supply for storage reservoirs, in basins where the supply is from melting snowfields or inconstant or intermittent streams.

The engineer asks: "Is the rainfall of a certain locality sufficient and constant enough to guarantee the desired water supply?" and the question is for the practical meteorologist to answer.

One cannot fail to see how intimate is the relation between climate and irrigation. The source of all running water is primarily the rain that falls from the heavens. Rainfall, which appears

at first so simple, is a very intricate and complicated subject, and a discussion of its causes, conditions and modifications would be far beyond the designs and limits of this paper. It is sufficient to briefly show how the peculiar topographical features and geographical situation of these far western States have given us an arid climate, that is, one with little rainfall. The very cause of our arid climate is the mountain barriers where the streams take their source, which absorb the moisture that would otherwise fall over the plains and valleys. So one of the relations that irrigation has to climate is that an arid climate necessitates resort to it. Another and a very important one is that in an arid climate the irrigation supply is constantly and rapidly diminished by absorption and evaporation.

The work and methods of utilizing the available water supply belong in the province of the hydraulic engineer, but the causes of the water supply, both primal and modifying, are strictly and properly in the province of the meteorologist. Rainfall we consider a primal cause, while absorption and evaporation are modifying causes that effect any water supply.

THE OBSERVATIONS.

The National Weather Bureau and its predecessor, the Signal Service, have for many years observed and studied the climate of the so-called "arid region," and of late their work has been supplemented by that of a larger corps of voluntary observers under the direction of State Weather Services. Not many years hence, as the result of this vast network of observations, every important feature of our varied climate will be known and understood. Enough is now known, however, to supply the principal facts affecting water supply, water storage and irrigation. What is most lacking is a series of observations of snowfall high up in the mountain ranges. It is taken for granted, although not surely known from observation, that the precipitation on the mountain summits is much greater than in the valleys below where it has been measured. Just how much should be accurately determined,

and although such determination is exceedingly difficult, laborous and expensive, it is essential and should be provided for.

What, it may be asked, is included in the arid region? All the inter-mountain country and portions of California and Oregon; also the country east of the Rockies as far as the 100th meridian at least, must be considered arid or semi-arid. It comprises those sections of the United States over which the rainfall is the least, the temperature highest, evaporation most decided, and the amount of sunshine the greatest, thus presenting the phases of climate apparently most adverse for agriculture or any industry where abundant water is essential, and irrigation therefor, is indispensable.

The total rainfall is abundant, and even heavy, west of the Sierras; it is, aside from exceptionally dry localities, considerable in the remainder of the arid region; but in its unequal distribution throughout the year, lies the difficulty or actual impossibility of carrying on agriculture without the aid of irrigation. Not only is the seasonable distribution of rainfall in the arid region unequal, but so also is the geographical distribution, thus further complicating the subject of water supply. Taking an annual rainfall chart of Utah, tabulated from a long series of observation, we see by far the greatest proportion of rainfall occurs throughout the central part of the Territory from north to south; throughout this region, comprising one-third of the area of the Territory, it is over ten inches annually, and the extreme amount, that is to say, of sixteen inches or more, occurs in the north, in the counties lying on each side of the Great Salt Lake. Ogden has the greatest precipitation recorded at any station; St. George, in the extreme southwest, has the least. The causes of the greater precipitation in the north are probably the more northward track of the majority of the storm areas, and the high mountains near the eastern shore of the Great Salt Lake. In tables which have been furnished to the committee on statistics for this congress, the annual inequality of the rainfall, varying from one-third less than average amount—which is about seventeen inches—to one-third greater than the average amount, has been fully shown; so also has the seasonable inequality, by the greatest part of the precipitation

occurring in the winter season, from October to May. It is heaviest in April usually, and lightest in July or September. As will be seen from a study of the tables, from one and a half to two times the amount of the precipitation falls over Utah during the winter season that falls during the growing season. Herein lies both the necessity and opportunity for water storage in natural or artificial reservoirs.

There are twice as many acres of arable land in Utah uncultivated, because unirrigated, as there are acres under irrigation, and the condition is a similar one in the other Territories and States. Under the simple methods heretofore followed, these lands cannot receive water. The question for solution is, can these lands be irrigated under the more advanced and expensive methods, pursuing irrigation engineering to its utmost profitable limit. Nothing in the way of climate prevents, and if there are topographical difficulties they are for the engineers to surmount, as has been in railway engineering.

The rainfall in cubic inches of water has been computed for the several States and Territories as follows:

Utah an annual average of about fourteen cubic miles; Nevada, about the same, Colorado, twenty cubic miles; Arizona, twenty-two and three-tenths cubic miles; New Mexico, twenty-five and three-tenths cubic miles; California, fifty-six and three-tenths cubic miles. But it must not be supposed that this enormous quantity of water, or even an approximate part of it, is available for purposes of irrigation in any particular year. A very large amount is lost by absorption and evaporation, and besides, the yearly fall varies greatly in different years, as has just been shown for Utah, and as is true, also, for other States and Territories.

Absorption cannot be treated here, and let it suffice to say that the absorptive power of the soil in this dry region is enormously great, especially during the heated and excessively dry periods of the summer. It should be provided against, as far as possible, in the materials of which the irrigation works are constructed. Evaporation will be spoken of later.

AN INTERESTING FEATURE

of the Utah record is the percentage of rainy days that occur in each month; thus, for January, the percentage is thirty-six, or a probability of rain occurring in a measureable amount in one out of every three days; for July, twelve per cent., probably one in eight; September, thirteen per cent., about the same as July. This probability is entirely independent of the quantity of rain that may fall on any one day, and the days of rain are not distributed uniformly throughout any month, but are usually "bunched," two, three, or even more rainy days occurring in succession. The summer rains occur mostly in showers, which are often torrential in and adjacent to the mountains. The tables and records referred to are from Salt Lake City, but observations from other points, as far as they have been extended, show similar results. The rainfall is unequal, both seasonably and geographically, unfortunately in the former case, since, as the bulk of it occurs in winter and early spring, the water, except what precipitation is in the form of snow, must either run to waste, or else be stored a long time before being used in irrigation.

Observations have clearly shown that enough precipitation occurs in the great drainage areas to give an abundant water supply for irrigation purposes, provided it can be collected and retained until needed for distribution.

Although evaporation observations have not been as complete and extended as might be desired, they have sufficiently shown that evaporation in this arid region goes on at an enormous rate; because of a great amount of sunshine, brisk to violent winds, and an atmosphere with great capacity for moisture. To say that the atmosphere over a certain region has a great capacity for moisture, is the same as to say that its humidity is low, both absolutely and relatively. By absolute humidity is meant the actual weight, in grains, of the vapor present in any given volume of air; by relative humidity is meant the ratio which the amount of vapor present in the air at any temperature bears to the amount which the atmosphere, at that temperature, could hold if saturated; for there is a certain limit, called saturation, to the amount of moisture

which the air can hold, which limit increases with the temperature. In saturated air, evaporation cannot take place; in low humidity it is rapid. The absolute humidity has been calculated for Utah as follows:

Ranging from 1.1 grains to the cubic foot during January, at a temperature of 26 degrees; to 1.7 grains in April, temperature 48 degrees; to 2.4 grains in July, temperature 77 degrees; to 1.8 grains in October, temperature 49 degrees. The relative humidity, using Salt Lake averages for the past twenty years, which are probably too high for Utah in general, is as follows, by monthly means: January 65, February 64, March 55, April 50, May 46, June 39, July 36, August 37, September 38, October 48, November 57, December 66. From the foregoing we may calculate the absorptive capacity of the air roughly, as follows, in grains vapor to the cubic foot of air: January 0.62, February 0.84, March 1.31, April 1.89, May 2.58, June 3.86, July 5.17, August 5.02, September 3.57, October 1.98, November 1.16, December 0.74. This gives an idea of the limiting possibilities of evaporation in Utah. Comparisons have shown that the climate of Utah is dryer than some of her neighbors, but moister than others. Nevada and Arizona are dryer, Colorado and Idaho are less dry.

If only fifteen or twenty inches were evaporated annually, it would be a fact of only minor importance to irrigation; but over much of the arid region the water which would be evaporated if freely exposed, would attain a depth of from five to ten, and possibly, in some cases, fifteen feet annually. Professor Gilbert has estimated the annual evaporation over Lake Michigan as equal to a layer of water twenty-two inches deep, while that over Great Salt Lake is estimated at eighty inches annually. Professor Thomas Russell calculated the evaporation at Salt Lake City to be seventy-four and one-fourteenth inches annually; that is, more than six feet. That is a large amount to be removed from the reservoirs and ditches of any irrigating system, yet it should not be discouraging, since, although evaporation in Arizona is much greater than in Utah, Lieutenant Glassford, who has given the matter much study, says, and maintains it by evidence, that not

only is the original rainfall to the southward of the Great Divide, over the watershed of the Gila river system, more than plentiful, but the available water supply, after deducting the loss by evaporation, is abundant to supply three times the amount of land now under irrigation. Two statements I copy verbatim from his report: "Twice each year there occurs sufficient aqueous precipitations in Arizona to reclaim every acre of land worthy of such reclamation." "The co-efficient of evaporation, though absolutely high, yet is relatively so small in comparison with the actual and projected storage basins that it may be economically disregarded as a vanishing quantity."

Over Colorado the possible evaporation is computed as less than that of Utah, ranging from sixty-five to seventy inches annually. Over Utah it is quite constant, and averages seventy to seventy-five inches. In New Mexico the possibility of evaporation is from seventy-five to eighty inches. In Arizona the figures are widely varying, ranging from fifty-five inches in the mountains to one hundred inches in the south. This would indicate that in any storage system by irrigation in southern Arizona, the reservoirs would not be so much affected by evaporation as would be the ditches in lower-lying lands.

In Nevada, evaporation possibilities are greatest, being from eighty to one hundred inches annually. The great amount of sunshine over southern California, and over the inter-mountain region as well, enormously facilitates evaporation. It complicates the question of agriculture because, occurring in this maximum amount in mid-summer, the extreme dryness resulting is adverse to growing crops, not only parching them, but lessening the water supply.

High winds, especially hot and dry, as they are apt to be in the arid region, greatly facilitate evaporation. This they do by causing a constant renewal of the air over the evaporating surface, taking away the air as it becomes laden with moisture, and supplying dry air in its place.

NEED OF FORESTS.

Evaporation cannot be prevented, but it can undoubtedly be greatly diminished by the cultivation of forests. There are those who deny this as well as those who dispute that rainfall will be increased by timber culture and general tilling of the soil. The data upon which to decide the latter point is too meagre, but that forests prevent excessive evaporation is almost self-evident. One way in which they would effect this is by sheltering the reservoirs and ditches not only from the sun, but also from the winds, which, as we have seen, are agents in evaporation. Whether forests increase rainfall or not, there are many reasons for holding that they tend to make the distribution of rainfall more uniform throughout the year. This suggests the rather idle speculation that in time to come the forests raised by irrigation might at least render it no longer a necessity.

Whatever be done about growing new trees, it is positively essential for the success of irrigation projects that these forests still left upon the mountain sides should be preserved. They hold the fields of snow far into summer, permitting them only gradually to melt, which otherwise would be turned into terrific torrents in the earliest spring sun, and go on their way to destroy reservoirs and ditches, perhaps property and life itself, or at least run fruitless to the sea.

The manner in which precipitation occurs—whether in steady rains or in heavy showers, has an important bearing on the question of storage reservoirs. In New Mexico and Arizona, torrential rainfalls, some of them veritable “cloudbursts,” are very frequent; in Arizona thirty to forty per cent. of the entire precipitation occurs in heavy showers. In Utah they are not uncommon. Such conditions require great care in the construction of reservoirs to make them strong enough to withstand great floods and with waste-wiers, which will allow the gradual overflow of excessive amounts of water.

The purpose of this paper has not been to deal exhaustively with climate, rainfall and irrigation for the instruction of experts,

seems about identical with that of Cache Valley. All crops of small grain give there a very large yield; corn ripens; excellent apples (without worms), pears, plums, cherries and small fruits are raised. The hardy varieties of peaches and grapes generally succeed. But lucerne seed and honey are, curiously enough, the staple products exported. Upon the whole, there is not in Utah a farming community more prosperous than that of Ashley Valley. The present flow of water in Ashley's Fork is barely sufficient to irrigate the land now under cultivation, but—by properly utilizing as storage reservoirs several natural lakes on top of the Uintah plateau—the volume of water can be so increased during the irrigating season as to water the entire amount of tillable land in the Valley without stint.

Lucerne Valley—in altitude and climate identical with Ashley Valley—lies close to Green River on the south side of Henry's Fork, well sheltered from winds by surrounding sandstone reefs. It contains over eight thousand acres of land with superior soil—a warm, sandy loam, free from alkali and rocks. In 1892 the "Lucerne Land & Water Company," a Salt Lake corporation, commenced the construction of the "Sheep Creek Canal," for the purpose of irrigating Lucerne Valley and some adjacent benches, in all sixteen thousand acres of land. At present the Sheep Creek Canal is completed as far as concerns the irrigation of Lucerne Valley. Thirteen miles of main canal conduct the waters of Sheep Creek to the head of the Valley, over which it is distributed by over twenty miles of laterals. Desert filings cover already sixteen hundred acres of land; this tract is fenced, and last summer farming, gardening and tree-planting were commenced with very gratifying results. The balance of the land is now open to homestead entry; water can be bought from the Lucerne Land & Water Company on reasonable terms. Lucerne Valley will have an abundance of water, and with its excellent soil ought to make a very desirable place for settlement. Besides the two valleys described, there are good sized tracts of land in other localities upon which water can be brought at reasonable expense.

While in the aggregate a very large number of cattle are

raised and pastured in our "neglected corner," the business of stock-raising is mostly conducted in an indolent, happy-go-lucky manner, without much enterprise or effort. The summer range is most excellent and practically unlimited, but the winter pasturage is entirely insufficient to keep the stock in condition, and the deficiency cannot be supplied—as the stockmen are trying—by the small amount of hay to be cut in the narrow bottoms of the streams.

The large Uintah Plateau is practically covered with fine forests of Norway pine, red and white pine, spruce and balsam. The "noble red men" on the adjacent reservations have formerly been in the habit of setting fire to the timber in the fall so as to drive the game out of it; for that reason large patches show only small young trees, but many thousand acres of timber suitable for merchantable lumber are yet standing. A number of small saw mills are in operation, but for lack of transportation facilities they only supply local demands.

The most important mineral found is a bituminous coal of good quality, which crops to the surface in Lucerne Valley, Ashley Valley and many other places; it undoubtedly underlies the sandstone formation of the country and exists in inexhaustible quantities. The Brush Creek Copper Mines and the Asphaltum Mines near Fort Duchesne are too well and favorably known to make further comments upon the occurrence of these two minerals necessary. Promising outcrops of iron or of silver—lead ores are frequently observed; and in spite of the recent malodorous fake, otherwise known as the "Deadman's Mine," many good prospectors believe that eventually, important gold mines will be discovered.

If one of the many Denver & Salt Lake Short Line Railways—constructed on paper—should happily materialize, it will cross this country, and the great opportunities for irrigation enterprises, the pasture and timber lands, the vast coal fields, unexcelled asphaltum beds and rich copper mines, may be developed and utilized, but that will be another story.

SOME OBJECT LESSONS ON IRRIGATION.

BY J. M. GOODWIN.

Among the incidents of American history few possess more thrilling interest than the manner in which dense forests in the United States were leveled, that here and there spots of land might be cleared and cultivated by the hardy pioneers of a new world. The transformation of the country from almost an impenetrable wilderness of trees to fields of waving grain and the upbuilding of happy homes, presents one of the most pleasant pictures of modern civilization on the arable lands of our glorious country. The people who subsequently pushed out into the deserts of arid America, and through systems of irrigation redeemed the soil and built up new empires deserve equal praise along with the early pioneers of America, since their works and labors were surrounded with equally as many dangers and privations, while the results in transforming the country are about as great. The men who, forty years ago with pick and shovel and hard labor of hands, dug the ditches which have made Utah valleys so fruitful, deserve being crowned as heroes as much as the brave men who won laurels in battles of our country. Removed as they were from other people and supplies, they nevertheless went forward and achieved such wonderful victories over nature and the elements, as to make the once parched lands the most fruitful of any, and brought happiness to all the people. Thanks to the many lines of communication piercing the arid regions of the West, it is now an easy matter to subdue the deserts and open up great tracts to settlement, just as good as were the acres in Utah which have so long been classed as the richest of garden spots, because so well irrigated and cultivated. Utah and Idaho both offer fine inducements for people to settle on such lands.

The man who has cultivated irrigated land will never be content to own lands dependent upon nature supplying the moist-

ure simply through precipitation. He would deem such a change a surrender of a certainty for an uncertainty in crop production.

Probably the best object lessons in irrigation to be found anywhere is seen in Utah and Idaho, extending from the Utah-Arizona line northward to Montana, a distance of six or seven hundred miles, and over a country taking in all of Utah, a little of Colorado and southern Idaho. At the south we find a country so warm as to produce grapes, figs, English walnuts, almonds and some semi-tropical fruits, while the atmosphere is so dry as to give raisins ready dessicated on the vines. Under irrigation and the great heat thus developed, cotton, corn and all grains and fruits grow profusely. A dozen years ago, few localities presented a more desolate appearance than the valley of the Grand, of which Grand Junction, Colorado, is now the business center. The waters of the river conveyed to these once barren lands have changed the scene to that of fields of wonderful production in grains and root crops, while the numerous orchards are so prolific in fruit of such excellence in appearance, size and flavor, that for the past three or four years the citizens have annually held their "peach day" at Grand Junction, to which all the world are invited to come and see and partake, and their thousands of visitors are not only made welcome but are loaded down with fruits to carry away. And this is on lands from which hostile and savage Indians were driven only thirteen years ago, and the irrigation system was not introduced until several years afterwards.

Great Salt Lake Valley has been written about so much and the City is so well known, that simply to mention the fact that irrigation has added much to their attractions is sufficient. The north end of this valley, however, is now undergoing a transformation scene, a resultant from the construction of the largest and most expensive canal system in Utah, and known as the Bear River Canal, which will cover over one hundred thousand acres of rich lands and which is being rapidly colonized.

Upper Snake River in Idaho has been tapped the past six or eight years by numerous canals, and a country twenty to thirty miles wide and over one hundred miles long, which five years ago

was all a sagebrush desert, not producing half enough to supply the small population, has grown to a rich agricultural district, from which six or eight thousand carloads of produce is being shipped this season. Wheat, fifty bushels per acre, oats, sixty, potatoes, two hundred to five hundred bushels, and hay two to five tons are talked of as common or average products. This rapid growth of country has made the Utah Northern a good paying branch of the Union Pacific System, and the future promises even better things.

Southwestern Idaho, taking in the Snake, Boise, Paysons of all as to results of irrigation. Up to the building of the Oregon Short Line Railway, ten years ago, Boise City occupied an isolated position, being from thirty to sixty miles from any towns and two hundred and fifty miles from a railway. He who went there by stage in those days had from forty-eight to sixty hours constant travel over an unbroken desert. The town was truly an oasis in the desert. Its fruit and shade trees, gardens, etc., so different from the stunted sage of the plains, added so much beauty to the site as to at once charm the stranger and make him feel at home. Only the bottom lands were then used for cultivation, and the acreage was very small. Since then the ditches and canals have climbed the bluffs and now carry water over the elevated plains until the desert is melting away, and not only farms with homes are springing up in all directions, but prosperous towns have arisen and become active business centers, while no finer fruits, no better vegetables and grain crops are produced anywhere than upon these lands. Experiments in prunes give promise of this locality becoming a prominent prune country, while the warm dry climate has been proven to be just adapted to hop raising because of freedom from insects, mildew, etc., while the product is three to five times as much per acre as in the hop districts of New York.

Over all this vast country thus partially described, and which geographically and physically is really a part and parcel of Utah, the mother of western irrigation, there are awaiting many acres of the public domain for settlers who, with energy and labor, can soon make for themselves good homes, in which peace, happiness and prosperity should dwell. These lands are bordered with majestic mountains, which catch the falling snows in winter and store away ample water to send down in summer through ditches, the life giving fluid to gladden the parched earth and bring forth fruitful crops to cheer the hearts of the toiler and the dear ones of his household.

CACHE COUNTY.

ITS IRRIGABLE AND OTHER FEATURES.

It has been said that Utah was a desert until reclaimed through irrigation and cultivation.

This may have been true of many sections, but Cache Valley was always fertile, well watered and green. It was a veritable paradise for the Red Man. It was productive before the advent of the plow and well watered before the introduction of systematic irrigation.

The people of this valley are always assured of plenty of water from snows, springs and crystal lakes. Canals five and ten miles long are now drawn from the mountain streams without any expense for dams. In the future the canyon walls will be joined by masonry, and billions of gallons will be stored in the reservoirs to be constructed to supply water for irrigation and manufacturing purposes.

Cache County has more acres under cultivation than any other county in Utah, and in the production of wheat will challenge any district of equal size in the world. Fifty or sixty bushels of wheat to the acre and no failure of crops! Oats running as high as eighty-five bushels to the acre, barley about forty-five, potatoes from four hundred to six hundred per acre with specimens nearly two feet in circumference. Fruit, apples and berries are raised in great quantities and find a good market. Feeding cattle brought from other districts is becoming a profitable industry.

There is no better field for investment than Cache County. Logan City, the County seat, is one of the most prosperous cities of the west. It has a population of over six thousand, and is noted as a seat of learning.

The Utah Agricultural College is located here, and this college is one of the very best in the country. Its work is thorough and in keeping with the most intelligent methods. The Brigham

Young College and one of the four Mormon Temples of the Territory are also located here.

The County has a population of about sixty thousand, divided among twenty-three thriving settlements. Its wealth is built upon solid foundations and its future progress will be rapid.

THE BRIGHAM YOUNG COLLEGE,

One of the foremost institutions of higher learning in Utah, was founded in 1877 by Brigham Young, who conveyed to a board of trustees a large tract of land, located south of Logan City.

It is the general policy of the College to promote the higher educational interests of the people, broadly and generously interpreted. It is its aim to provide an education liberal and thorough, embracing not only mental discipline and physical training, but moral and spiritual culture, as an essential part of the development of a symmetrical character.

The following courses are offered: Course in General Science, four years; Course in Letters, four years; College Preparatory Course, three years; Normal Course, three years; Business Course, three years. The first two of these courses lead to degrees; the others to certificates of graduation. The faculty numbers thirteen.

The chemical, physical and biological laboratories are fully equipped. There is an excellent museum. The well lighted reading-room will accommodate one hundred and thirty readers. The library contains a carefully selected reference library of two thousand volumes.

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THE BRIGHAM YOUNG COLLEGE has hundreds of the best irrigated farms for sale or lease. Address George W. Thatcher, President, or J. E. Price, Secretary B. Y. College Board, Logan, Utah.

THE LAND GRANTS FROM THE UNITED STATES

TO THE NEW

STATE OF UTAH.

Compiled for the Utah Irrigation Commission.

The Enabling Act passed at the late session of the United States Congress, whereby the Territory of Utah can become a state of the Union, conveys to such state outright, practically all the national lands of an irrigable character remaining within its borders, as well as a large amount of pastoral and forest areas.

This change of the control of the public lands is a matter fraught with the utmost importance to the future welfare of the coming state, and most favorably so since it permits the more immediate reclamation and settlement of hundreds of thousands of acres in ways beneficial not only to the commonwealth, but to coming settlers, while thousands of acres can be leased for grazing and other purposes vastly to the benefit of Utah's treasury.

The cessions under this act for specific purposes are as follows:

Public Buildings at Capital of State,	-	-	64,000	acres.
University of Utah, additional grant,	-	-	110,000	"
Agricultural College,	-	-	200,000	"
Irrigation Reservoirs,	-	-	500,000	"
State Insane Asylum,	-	-	100,000	"
School of Mines,	-	-	100,000	"
Deaf and Dumb Asylum	-	-	100,000	"
Reform School,	-	-	100,000	"
Normal School,	-	-	100,000	"
Institution for the Blind,	-	-	100,000	"
Miners' Hospital,	-	-	50,000	"

1,524,000 acres.

In addition to these specially named grants, there has also been ceded for the purposes of the common schools, a further amount of lands, which embraces all the sections numbered two, sixteen, thirty-two and thirty-six, in every township, and "where such sections or any part thereof have been sold or otherwise disposed of by or under the authority of any act of Congress, other lands, equivalent thereto, may be selected in such manner as the Legislature may provide, with the approval of the Secretary of the Interior."

This means the equivalent of one-ninth of the entire area of the Territory for school purposes, or some six million acres. What is known as the Carey act further grants one million acres for reclamation purposes, which has special conditions to be complied with. We thus find that under the enabling act, the new State of Utah will own or control

For Specific Grants,	-	-	-	1,524,000	acres
For Reclamation Purposes, (Carey Bill.)				1,000,000	"
For Common School Purposes,	-		-	6,000,000	"
Total,	-	-	-	8,524,000	acres

Of this amount over one-half is pasturage or forest land, as may be selected. If the successful way in which the people of Utah have brought one million acres under irrigation is any criterion, surely its agriculture future is a brilliant one.

WHAT WAS FOUND UNDERNEATH THE CITY OF SALT LAKE.

SUBTERRANEAN WATER FLOW.

After piercing the sub-stratas to a depth of 1073 feet below the surface of the valley, and passing other underground flows of water, the great artesian well sunk by the Rio Grande Western at its shops at Salt Lake encountered a flow of 120 gallons per minute rising four feet above the surface, and raising fifty-nine gallons to a height of thirty feet. This means a discharge of nearly 85,000 gallons of water into the tanks every twenty-four hours. The water will be available for locomotives and other uses of the company.

The sinking of this well, the method of boring and the stratification to a depth never before penetrated in Salt Lake, should prove of equal interest to agriculturists and geologists, and this interest is shared by all who are interested in the question of drawing on subterranean water for irrigation and other uses.

METHOD OF BORING.

The well was commenced with six-inch pipe, which, at a depth of 500 feet, was abandoned, because of the unsatisfactory methods used to drive it, and a four-inch pipe driven inside of the other was used. When the four-inch pipe was adopted the work was turned over to Messrs. Candee & Westphal, Salt Lake City, who introduced a method of boring ahead of the pipe, instead of driving it. Their apparatus is a revolving column of two-inch pipe running inside of the well, and adjusted so as to be raised or lowered at pleasure. To a lower end of this was attached a cutting tool made on the principal of the augur, and the upper end was connected by hose to a powerful pump, which forced water to the bottom, and washed out the borings. With this apparatus it was not necessary to drive the pipe. The tool could be driven and revolved to a depth beyond the pipe, which would settle as far as allowed, the only precaution necessary being to prevent the pipe from dropping into the earth. By this means the pipe remained loose, and could all have been recovered had the well proved a failure.

THE STRATAS PIERCED.

Below is a record of the sub-stratas, which is not absolute, as several of the clay stratas were calcareous, and many small flows of water that would have proved sufficient in a well intended for limited irrigation, were passed, and are not listed in the record. Where only the water would have been required and pressure a secondary consideration, a number of those small flows could have been combined and a well of sufficient capacity obtained at a much less depth than in the present instance.

REMAINS OF A FOREST.

At a depth of 438 feet from the surface decomposed wood was discovered, and forest refuse not decomposed, was encountered at 667 feet, and again at 730 feet. Coarse gravel, as round and smooth as could be found in the bed of City creek canyon, and as large as a walnut, was pumped up from a depth of 730 feet, and a piece of hard-pan, through which the tool had weighed nearly five ounces, came to the surface from below.

FOLLOWING IS THE RECORD.

Thickness, Depth Feet. Feet.		Thickness, Depth Feet. Feet.	
Thin stratas of clay and sand.....	130	Soft blue clay	40 609
Clay and hard pan.....	40 170	Sandy blue clay.....	40 649
Red sand, with a little water.....	30 200	Hard pan	2 651
Clay and hard pan, very hard.....	60 260	Bank forest bed sand, 40 gallons	
Gray sand, with a little water.....	5 265	per minute	16 667
Clay and sand in thin stratas.....	22 287	Sandy gray clay, 35 gals. per min.	18 685
Sand, small flow	20 307	Forest bed sand, "red".....	35 720
Clay	30 337	Coarse gravel, 100 gals. per min.	10 730
Sand, small flow.....	13 350	Blue clay	76 806
Hard clay.....	6 356	Alternate clay and sand, every 12	
Sand, small flow.....	8 364	or 18 feet small flow.....	84 890
Clay.....	10 374	Hard pan	8 898
Sand, no flow	18 392	Granite sand and coarse gravel, 15	
Clay	20 412	gallons per minute.....	11 909
Sand, small flow.....	4 416	Blue clay shale.....	16 925
Clay.....	10 426	Gray clay	24 949
Blue sand, black wood, water 10 to		Sandy gray clay, small flow.....	13 962
20 gallons.....	12 438	Quicksand	15 977
Clay	5 443	Blue clay	21 998
Blue sand, wood, water, 15 to 20 gal-		Sandy blue clay 2 gals. per min.	11 1009
lons	30 473	Quicksand.....	10 1019
Hard clay.....	10 483	Gray clay	11 1030
Sand and gravel.....	1 484	Fine blue granite sand, 3 gals. per	
Clay	12 496	minute	3 1033
Gravel.....	4 500	Tough blue clay.....	12 1045
Gray clay, sandy	27 528	Hard pan	2 1047
Tough blue clay.....	30 558	Fine sand, 112 gals. per min.....	21 1069
Hard pan	3 561	Hard blue clay	3 1073
Granite sand	8 569		

It is noticed also that the flow is increasing since boring was discontinued. Accurate measurements, taken three days apart, developed an addition of eight gallons per minute, and indicated a heavier pressure.

